354.1

Library of the Museum

OF

COMPARATIVE ZOÖLOGY,

AT HARVARD COLLEGE, CAMBRIDGE, MASS.

The gift of the British Museum.

No. 13,198
February 23, 1898.

13,198

354.1

PRESENTED

BY

The Trustees

OF

THE BRITISH MUSEUM.

EB 23 1898

CATALOGUE

OF THE

MADREPORARIAN CORALS

IN THE

BRITISH MUSEUM

(NATURAL HISTORY).

VOLUME III.

THE GENUS MONTIPORA,

THE GENUS ANACROPORA.

BY

HENRY M. BERNARD, M.A.

LONDON:

PRINTED BY ORDER OF THE TRUSTEES.

SOLD BY

LONGMANS & Co., 39 PATERNOSTER ROW;

B. QUARITCH, 15 PICCADILLY; DULAU & Co., 37 SOHO SQUARE;

KEGAN PAUL & Co., PATERNOSTER HOUSE, CHARING CROSS ROAD;

AND AT THE

BRITISH MUSEUM (NATURAL HISTORY), CROMWELL ROAD, S.W.

1897.

All rights reserved.

LONDON:

PRINTED BY WILLIAM CLOWES AND SONS, LIMITED,

STAMFORD STREET AND CHARING CROSS.

PREFACE.

In this third volume of the Catalogue of Madreporarian Corals Mr. Bernard has included the two closely allied genera *Montipora* and *Anacropora*.

The three volumes now finished form together a very complete monograph of the Madreporidæ, which is one of the chief reef-building families of Stony Corals.

The value of this work from a scientific point of view may be gathered from the fact that there has been no comprehensive systematic work on the Stony Corals since the classical treatises of Milne-Edwards and Haime published more than forty years ago; while in the time which has elapsed since then exploring expeditions have been adding new and beautiful types to the Collections in the different European Museums, which have consequently far outrun the system of these authors.

The increased wealth of our own Collections may be cited in illustration of this. In 1878, when Brüggemann prepared his MS. Catalogue, there were only 41 specimens of Montipores, divisible into 16 species. There are now more than 400 specimens, divisible into 116 species, about 80 of which are new. The total number of species has risen from 32, as left by Milne-Edwards and Haime, to 142. In using the word species, I would call attention to Mr. Bernard's introductory remarks (p. 17) as to the applicability of the term

to the isolated specimens and chance fragments of which Museum Collections are largely made up.

For the great increase in the number of specimens just mentioned, the Trustees are indebted mainly to Messrs. Bassett-Smith, R.N., J. J. Lister, W. Saville-Kent, and Prof. A. Haddon. Further, the specimens of the Montipores in the collections recently made by Mr. J. Stanley Gardiner and Dr. Arthur Willey, have been worked out by Mr. Bernard, and the types of seven new species have become the property of the Museum; the descriptions of these are given in an Appendix.

In order to facilitate the identification of the earlier types of Lamarck, de Blainville, and Milne-Edwards, Mr. BERNARD made a special study of the extensive Collection of Montipores preserved in the Paris Museum.

Mr. F. JEFFREY BELL, the member of the permanent staff who has charge of the Coral Collection, has rendered Mr. Bernard most valuable and efficient aid throughout, especially in the preparation of the plates and in editing the text.

As in Vols. I. and II., photographs of the more important specimens have been reproduced by collotype by Messrs. Morgan and Kidd; while four plates of enlarged drawings of details have been lithographed by Mr. Percy Highley. No pains have been spared by these artists, who have all shown remarkable interest in their work.

W. H. FLOWER,
Director.

British Museum (Natural History),
November 1897.

TABLE OF CONTENTS AND SYSTEMATIC INDEX.

INTRODUCTORY REMARKS ..... *page* 1

MONTIPORA.

I. Historical 3
II. The Living Polyp and its Anatomy 7
III. Morphology 7
IV. Affinities of the Genus 11
V. Diagnosis of the Genus 13
VI. Geographical Distribution 13
VII. A General Review of the Variations Presented by the Representatives of the Genus 14
VIII. Concluding Remarks 16
List of the Species of the Genus Montipora 18

DESCRIPTIVE PART.

Page

Group I. Glabrous.

1. exigua 20
2. subtilis 21
3. granulosa 21
4. stratiformis 22
5. explanata 23
6. tenuissima 24
7. porosa 25
8. reticulata 26
9. crassi-reticulata 27
10. pallida 27
11. punctata 28
12. complanata 29
13. auricularis 30
14. exserta 31
15. glabra 32
16. obtusata 33
17. bolsii 34
18. erosa 35
19. solida 35
20. spongodes 37
21. divaricata 39
22. mollis 40
23. levis 41
24. compressa 42
25. alcicornis 43
26. fruticosa 44
27. spicata 45
28. rubra 45
29. superficialis 46
30. nana 47
31. digitata 47
32. tortuosa 48

Group II. Glabro-Foveolate.

33. ramosa 49
34. rotunda 50
35. spatula 50
36. marenzelleri 51

Page

GROUP III. FOVEOLATE.

37. libera 52
38. turgescens 53
39. foveolata 54
40. socialis 56
41. caliculata 57
42. calcarea 59
43. irregularis 60
44. multiformis 61
45. angulata 63
46. gaimardi 64
47. indentata 65
48. palmata 66
49. rigida 68
50. limitata 68

GROUP IV. PAPILLATE.

51. venosa 69
52. spumosa 71
53. ænigmatica 73
54. brueggemanni 74
55. lanuginosa 75
56. flammans 76
57. lobulata 76
58. edwardsi 78
59. acanthella 79
60. fungiformis 80
61. bilaminata 80
62. guppyi 82
63. tubifera 83
64. crista-galli 84
65. gracilis 85
66. spongiosa 86
67. circumvallata 87
68. stalagmites 87
69. papillosa 88
70. denticulata 89
71. pulcherrima 91
72. prolifera 93
73. australiensis 95
74. patinæformis 97
75. undata 98
76. viridis 99
77. planiuscula 99
78. mæandrina 100
79. danæ 101
80. verrucosa 103
81. ambigua 107

Page

82. mammifera 108
83. sinensis 109
84. abrotanoides 110
85. fragosa 111
86. tuberculosa 112

GROUP V. TUBERCULATE.

87. perforata 113
88. scabricula 113
89. variabilis 114
90. annularis 115
91. stilosa 115
92. villosa 116
93. nodosa 117
94. mammillata 117
95. cactus 118
96. incrustans 119
97. stellata 120
98. inconspicua 121
99. challengeri 121
100. listeri 122
101. grisea 123
102. minuta 124
103. lichen 125
104. scutata 127
105. peltiformis 128
106. granulata 129
107. æquituberculata 130
108. expansa 131
109. incognita 131
110. phrygiana 133
111. informis 133
112. hispida 134
113. tuberosa 136
114. monasteriata 137
115. friabilis 138
116. aspera 139
117. fragilis 139
118. rus 140
119. crassi-tuberculata 141
120. amplectens 143
121. patula 144
122. effusa 144
123. frondens 147
124. trabeculata 148
125. ellisi 149
126. efflorescens 150
127. fimbriata 151

	Page
128. solanderi	152
129. striata	154
130. circinata	155
131. foliosa	156
132. crassifolia	162
133. plicata	163
134. hirsuta	164
135. bifrontalis	165

ANACROPORA.

I. Historical ..... *page* 167
II. Morphological 168
III. Definition of the Genus 169
IV. Relation of the Genus to Montipora 169
V. Geographical Distribution 170
VI. On the Classification of the Specimens 170

DESCRIPTIVE PART.

	Page
1. forbesi	170
2. gracilis	171
3. erecta	173
4. reptans	174
5. solida	175
6. spinosa	176

APPENDIX TO THE GENUS MONTIPORA.

	Page
136. pilosa	177
137. profunda	178
[41.] caliculata, var. piriformis	178
138. alveopora	179
139. saxea	180
[109.] incognita	181
140. myriophthalma	181
141. granifera	182
142. willeyi	183

Index of Generic and Specific Names 185

Explanation of the Plates 189

CATALOGUE

OF

MADREPORARIA.

VOLUME III.

THE MADREPORARIAN SUB-FAMILY MONTIPORINÆ (MONTIPORA AND ANACROPORA).

INTRODUCTORY REMARKS.

THE two genera dealt with in this volume bring the family of the Madreporidæ, as at present limited, to a close. The first volume contained the large and important genus *Madrepora*, the second the two genera *Turbinaria* and *Astræopora*, while this third volume contains the allied genera *Montipora* and *Anacropora*.

As will be explained in detail in the Introductions in this third volume, these five genera form a natural group inasmuch as they are all colonies of polyps with porous walls. The fusion of these walls forms what is called the cœnenchyma. Whereas the walls in the three genera *Madrepora*, *Turbinaria*, and *Astræopora* typically only fuse for a certain distance up, each polyp having a protuberant, conical or crater-like wall rising above the level of the cœnenchyma, the walls themselves being only of moderate thickness, in the two genera dealt with in this volume the walls are typically of great thickness, and the protuberant cone is more or less obsolete. Again, whereas in the first three genera the primitive laminate condition of the radial structures persists, in *Montipora* and *Anacropora* this is largely obscured, the radial and tangential structures together typically forming a spongy reticulum. The first three genera may, therefore, be usefully united in the subfamily Madreporinæ, in contradistinction to the Montiporinæ; the chief morphological differences between these subfamilies, especially the comparatively enormous development of the cœnenchyma in the Montiporinæ, being referable to the above mentioned characters of the walls of their component calicles. At the same time, it should be understood that individual Madreporine colonies

may show a very great development of cœnenchyma; and on the other hand, individual Montiporine colonies may be so thickly beset with calicles that the cœnenchyma appears comparatively scarce. These are merely individual variations within the limits of each genus, variations which appear at times to carry the types concerned beyond bounds, to the dissolution of one's system of classification. It is, indeed, the test of a natural system that the limits of the different genera can stand the strain of all the possible individual variations among their respective species.

In spite, then, of individual variations, the Montiporinæ may be generally described as colonies of polyps in which the porous walls have been thickened and specialised at the expense of the polyp cavities. The characteristic of the subfamily, therefore, is enormous development of the cœnenchyma with very feeble development of the calicles. Hence, of all the Madreporidæ, the Montiporinæ deserve before all others the title of cœnenchymatous corals. They come very fittingly at the end of the Madreporidæ, for in the Madreporinæ the cœnenchyma is a secondary and more or less subordinate tissue cementing the calicles together, and thickening the basal supports of the colony as a whole, the calicles themselves taking the lead in the building up of the stock; but in the Montiporinæ, this secondary tissue has become to all appearance the most important factor in the colony, not only forming the greater part of its mass, but developing all kinds of protective structures among which the degenerate polyps can lurk. So great, indeed, is the range of variation in the plastic cœnenchyma, as the following pages will show, that *Montipora* will in all probability ultimately prove to be richer in species than any other genus of Stony Corals.

In the following pages, these different cœnenchymatous specialisations are systematically arranged, where possible, in such a way as to show the lines along which they have travelled. The greater part of the volume is occupied with the genus *Montipora*, within which these often marvellous and beautiful variations have free play. The small concluding section deals with the interesting genus *Anacropora*, which is, in reality, little more than a group of very specialised Montipores. Its relations with the principal genus will be discussed in detail in the morphological introductions.

Genus MONTIPORA, Quoy and Gaimard.

(Manopora, Dana.)

I. HISTORICAL.

This genus was founded by Quoy and Gaimard for a coral from the island of Tonga. The definition of the genus was given as follows :—"Animals actiniform, short, with twelve tentacles, contained in cavities which are circular, immersed, regular, with but few septa (paucicannelées), scattered over a corallum which is either encrusting or glomerate, porous, highly echinulate, and provided with mounds or ridges." There is a figure of the specimen, which the authors, having first sketched "avec assez de soin," lost; their description of the type, which was named *Montipora verrucosa*, is largely based upon this figure.*

The work containing the above (published in 1833) had evidently been seen by de Blainville in MSS., for, in 1830, in the 'Dictionnaire des Sciences Naturelles,' lx. p. 353, he described the new genus of Quoy and Gaimard, quoting their MS., and practically repeating their definition. He placed the genus between *Gemmipora* (*Turbinaria*) and *Madrepora*, and among a number of other genera, including *Porites*, under the general heading "Les Madrépores." De Blainville identified their species *M. verrucosa* with Lamarck's *Porites verrucosa*, and transferred another of Lamarck's *Porites* (*tuberculosa*) to the new genus, which thus contained two species both of which had apparently been previously described by Lamarck. De Blainville at the same time noted the great difference between the calicles in *Montipora* and *Porites*. In 1836, the same author published his 'Manuel d'Actinologie'; by this time he had identified four more of Lamarck's species, viz. *Porites spumosa*, *P. rosacea*, *Agaricia lima*, *A. papillosa*, as belonging to the new genus. He divided these into two divisions, "tuberiform" and "explanariform." In the atlas to this work, he gave a figure (pl. lxi. fig. 1) of *M. verrucosa* Q. and G., which, however, does not at all agree with Quoy and Gaimard's original figure. As de Blainville had the opportunity of examining Lamarck's collection, this figure might be supposed to represent the *Porites verrucosa* of that author. This, however, is not the case. De Blainville's figure represents neither Quoy and Gaimard's nor Lamarck's *verrucosa*, and has therefore been a standing enigma to all who have worked over this ground. It represents a true *Montipora*, however, and has been here identified with the *M. obtusata* of Quelch.

In 1834, in his classical 'Beiträge zur Kenntniss der Corallenthiere des rothen Meeres,'

* 'Voyage de l'Astrolabe,' Zool., iv. (1833) p. 247; see also Atlas, Zoophytes,—pl. xx. fig. 11.

Ehrenberg suppressed the genus * (or, according to him, subgenus of the genus *Madrepora*) and redistributed the (Red Sea) species among the subgenus *Porites*.

In 1848, Dana, in 'The Zoophytes of the United States Exploring Expedition,' re-established and very greatly enlarged the genus, at the same time changing the name to *Manopora*,† on the ground that "*Montipora*" referred only to an unimportant feature, i.e. to a character not sufficiently typical. The name *Montipora*, in fact, could only apply to one division of his *Manopora*.

Dana (following on the lines sketched out by Ehrenberg) went far in advance of all previous writers in his attempts to establish a natural classification of the Stony Corals. The different methods of budding supplied him with one of his chief characters. His Madreporaceæ, characterised by lateral budding, were divided into three families:—1. The Madreporidæ, consisting of two genera *Madrepora* and *Manopora*; 2. The Favositidæ; and 3. The Poritidæ. *Manopora*, he thought might be deduced from *Madrepora* by the degeneration of the protuberant calicles. The species of *Madrepora* without apical calicles formed a connecting link between the two. This proposed derivation will be discussed in the following pages.

The genus, as left by Dana, contained twenty-nine species, sixteen of which had been found for the first time by the expedition. The remaining thirteen were drawn chiefly from the *Porites* of Lamarck and of Ehrenberg. In addition, two of Lamarck's Agariceæ were included, and a *Millepora* (*compressa*) of Linnæus (from the Mediterranean) was claimed as a true Manopore (v. *Montipora compressa*, p. 42).

Dana arranged his genus *Manopora* in six divisions:—

1. With short, tubiform (i.e. projecting) calicles, surface not papillose.
2. No distinct (projecting) calicles, surface papillose-asperate.
   (*a*) Free foliaceous or subramose;
   (*b*) Glomerate, encrusting.
3. Calicles immersed; surface uneven, not regularly papillose.
4. Calicles immersed; surface not spinuloso-asperate; interstitial spaces prominent, or raised in round verrucæ or long rugæ (= *Montipora* of De Blainville).
5. Calicles immersed, at the bottom of deep pits; surface not verrucose or papillose.
6. Calicles "superficial," immersed; corallum smooth and branched.

The order of these divisions is significant, inasmuch as it embodies Dana's view above noted that the Manoporæ were Madrepores which had lost their prominent calicles. This, however, as we shall see later, is not supported by the evidence which will be here adduced.

In 1849, Milne-Edwards and Haime (Comptes Rendus, xxix. p. 259, and later in the 'British Fossil Corals,' 1850) accepted the genus *Montipora* of Quoy and Gaimard. They united it with *Alveopora*, Q. & G., and *Psammocora*, Dana, to form the Montiporinæ, which is the second tribe of the Poritidæ, differing from the first tribe Poritinæ by the abundance of the spongy cœnenchyma, rudimentary or absent in the latter. In 1851 (Les Polyp. fossiles d.

* Ehrenberg appears only to mention the word *Montipora* in his index (p. 155) where it occurs among the superfluous or doubtful names.

† μανός, of loose texture.

terr. paléozoïques, p. 146), owing to some temporary misunderstanding the name was suppressed in favour of *Alveopora*, the Alveoporæ of de Blainville and Dana being called "Poraræa." In the same year, however, the authors published a monograph of the Poritidæ (Ann. d. Sci. naturelles, Zool. (3) xvi. p. 21) in which they restored the name. The genus, though closely associated with *Porites*, was said to have certain structural resemblances ("quelques rapports de forme") with the Madrepores. The authors described thirty-two species. Some of Dana's were considered to be synonyms of others, but the majority were accepted. In addition, they included two of Forskål's Red Sea Madrepores, two other Porites (*complanata* and *angulata*) of Lamarck, the former as *M. complanata*, the latter as *M. phrygiana*, Esper, while the original species of Quoy and Gaimard (*verrucosa*) is separated as *M. quoyi* from *Montipora verrucosa*, Lamarck, and a new species from the Red Sea, found in the Paris Museum, is described as *M. multilobata*.

No change was made in the genus or in the number of species in the third volume of 'Les Coralliaires' (1860).

In the year 1866, Professor Verrill, in a synopsis of the Polyps and Corals of the North Pacific Exploring Expedition (Proc. Essex Inst., v. p. 17) described several new species under the old generic name *Montipora*. Following Milne-Edwards and Haime, he placed the genus with *Porites* under the family name Poritidæ. In 1869, however ('Notes on the Radiata in the Mus. Yale College,' Tr. Conn. Acad., i. p. 501), he went back to Dana's classification and placed the genus under the Madreporidæ, while still rejecting Dana's generic name *Manopora*.

In 1875 (Appendix to Dana's 'Corals and Coral Islands') he revised the list of the corals given by Dana in his 'Zoophytes,' rejecting two of Dana's identifications, and making new species of the types affected.

In 1877–9, Brüggemann published several systematic papers on Corals, and added new types. He seems never to have quite satisfied himself as to the affinities of the genus. In two papers which appeared (in 1879) after his death (1878) it is variously placed. In the 'Corals of Rodriguez' (Phil. Tr., clxviii. p. 569) the Montiporidæ follow the Madreporidæ and Poritidæ. While, in the Journal d. Mus. Godeffroy, v. p. 201 ('Über Korallen der Insel Ponapè') *Montipora* occurs with *Porites*, *Turbinaria*, &c., under the Madreporidæ.

In 1878, Prof. Studer (MB. Ak. Berlin, p. 524), in describing the corals collected during the voyage of the 'Gazelle,' classed *Montipora* under the Poritidæ. But in 1880, the same author, in describing corals from Singapore (Mitth. Naturf. Ges. Bern, p. 22), adopted Dana's classification so far as to class *Montipora* with *Madrepora* under the same family Madreporidæ. He added one new species *Monticulosa* (v. *M. hispida*).

In 1879 appeared Dr. Klunzinger's Monograph of the Corals of the Red Sea. Next in importance to the genus *Madrepora* (represented by twenty-four species) comes the genus *Montipora*, represented by eleven species, three of which are described as new, the remaining being older species of Forskål, Lamarck, Ehrenberg, and Dana. The genus is placed with *Madrepora* under the Madreporidæ (the first family of the suborder Madreporacea), the

Madreporidæ being distinguished from the three other families, Poritidæ, Turbinaridæ, and Eupsammidæ. In this close union of *Montipora* with *Madrepora*, Klunzinger again adopts Dana's classification.

In 1884, Mr. S. O. Ridley ('On the Growth and Budding in the Madreporidæ,' Ann. and Mag. N. H., (5) xiii. p. 284) criticised Dana's view of the relationship between *Madrepora* and *Montipora*. He pointed out that while the budding in the former was centrifugal, i.e. from a central apical polyp, the budding in *Montipora* was centripetal, i.e. in an undifferentiated apex of cœnenchyma above the last formed polyps. *Madrepora* and *Montipora* are thus two distinct developments of Madreporidæ only deducible in remote geological time from some common undifferentiated ancestor. Ridley at the same time founded a new genus *Anacropora* which with *Montipora* formed the subfamily Montiporinæ, distinguished by the centripetal method of budding from the allied subfamily Madreporinæ with their centrifugal method of budding.

In the same year Martin Duncan, no doubt to some extent encouraged by Ridley's paper, returned to the classification of Milne-Edwards and Haime (Journ. Linn. Soc. Zoology, xviii. 1884). He removed the two genera *Montipora* and *Anacropora* from the Madreporidæ, and placed them, the "Montiporoida," as the second alliance of the Poritidæ. The calices are erroneously said to have "columella and pali." (See, however, p. 10.)

In 1887, in describing the reef corals collected during the cruise of H.M.S. 'Challenger,' Mr. J. J. Quelch placed the genus *Montipora* along with *Madrepora*, *Turbinaria*, *Astræopora*, and *Anacropora* under the family Madreporidæ. He described twenty-two species in all, five as new. One of these latter, however, viz. *obtusata*, is specifically identical with the *M. verrucosa* of Blainville (non Lamarck, non Quoy and Gaimard).

In 1888, Professor Ortmann,* in describing the corals in the Strasburg Museum, followed Dana in all essential points. He placed the genus with *Madrepora* under the Madreporidæ, and divided it very much as Dana had done. One specimen from the Indian Ocean is referred doubtfully to Dana's *M. gemmulata*, which had, however, already been transferred by Professor Verrill to *Turbinaria*. And a new type with protuberant calicles is described under the name *M. stalagmites* from Tahiti. He further described another new glabrous type under the name *M. scabriculoides*, which he later found to be identical with *M. exserta*, of Quelch.

In 1889, the same author,† having worked out a system of corals according to the structure of the walls of the individual calicles, which resulted in their being divided into "athecalia," "pseudothecalia," and "euthecalia," separated *Montipora* from *Madrepora* and derived it through *Alveopora* from *Porites*. In this second paper, the genus is divided into two groups only, and Dana's first group, viz. that with tubular calicles, is suppressed.

Lastly, in 1896, Miss Ogilvie ('Study of Madreporarian Types of Corals,' Phil. Trans.,

* 'Studien über Systematik und geographische Verbreitung der Stein-Korallen,' Zool. Jahrb., iii. (Systematik) p. 154.

† 'Beobachtungen an Steinkorallen von der Südküste Ceylons,' op. cit., iv. (Syst.) p 493.

clxxxvii. p. 388) places the subfamily Montiporinæ under the Madreporidæ, in which family she would also include the Alveoporinæ.

The present work was begun in the autumn of 1895. The representatives of this genus in the National Collection number some 450 specimens, most of which were hitherto either unnamed or only provisionally named. The collection had been recently enriched by specimens from different parts of the world:—From the China Seas, by Mr. Bassett-Smith, Staff-Surgeon R.N.; from the Great Barrier Reef and from West Australia, by Mr. W. Saville-Kent; from Tongatabu, by Mr. J. J. Lister; and from Diego Garcia, by Mr. G. C. Bourne. Further, the collection made by Professor A. C. Haddon (in the Torres Straits) was also added when the volume was advanced towards completion. In the literature there were 64 specific names of recorded types; of eleven of these latter the original specimens belonged to the National Collection, viz. those named by Brüggemann, Quelch, and certain duplicates of Dr. Klunzinger's collection which had been named by himself. After allowing for the suppression of names which appear to be synonymous, the genus, as here dealt with, contains about 135 types,* of which 81 are recorded as new. A brief statement of the morphological results obtained by the author in the course of this work, was published in the Ann. and Mag. Nat. Hist. for August 1897.

II. THE LIVING POLYP AND ITS ANATOMY.

Dana ('Zoophytes,' p. 490) notes that the polyps of the genus have twelve short tentacles forming a narrow margin to the oral disc; in some species they are mere crenulations of the disc. Among other colours, lilac, green, and yellow are mentioned, and the disc is often marked with radiating lines or spots of different shades.

Mr. Saville-Kent, in 'The Great Barrier Reef,' pp. 184 and 185, describes the very minute size of the polyps and the mostly "rudimentary" character of the tentacular elements, which may be merely inflated papillæ. These bulbous tentacles are shown in four coloured drawings representing the general aspect in the living state of fragments from specimens of four species ["M. scabricula (appr.)," "M. foliosa," "M. expansa (appr.)," and "M. verrucosa"]. In each case, an enlarged figure of an expanded polyp is also shown.

As far as I am aware, nothing is known of the anatomy of these degenerate, or, more correctly, stunted polyps and of their connecting soft parts.

III. MORPHOLOGY.

The youngest colony that I have found is a small nearly circular plate (3 mm. in diam.), composed of a saucer-like epitheca with raised edges and filled up by cœnenchyma, on the surface of which the polyp cavities open. The largest polyp near the centre of the colony may be assumed to have been the parent. It stands highest and is surrounded by an irregular

* A study of the Montipores in the Continental museums, at present only provisionally classified, would considerably increase this number.

ring of younger polyps. Most of these are developing close against the turned-up epitheca, which even seems here and there to form part of their walls. They appear also to slope out a little. The cœnenchyma, which appears to be composed of an irregular mass of jagged flakes tilted in all directions, but tending to lie horizontally, is densest in the centre of the saucer, while round the edges it forms a light reticulum. Beyond this reticulum, the elements of which tend to form the jagged plates just mentioned, no definite structure of the cœnenchyma can be made out at this stage. The edges of these horizontal plates are quite irregular, being generally deeply incised. The margin of each calicle is formed by one or more of these plates. The septa are not continuous ridges but vertical rows of spines from the edges of these horizontal plates. The new calicles appear to be formed by the grouping of the horizontal plates. This young stock is figured in the Ann. and Mag. N. H., ser. 6, vol. xx. pl. ii. figs. 1 and 2.

Comparing this young specimen with others both young and old, we may summarise the young stage of Montiporæ as follows :—

A well-developed saucer-like epitheca is filled with a mass of reticulum only slightly raised in the centre, where the calicle of the largest or parent polyp of the colony opens, while younger polyps open all round close to the epitheca.

The further typical development may be described as follows :—

The cœnenchyma.—The cœnenchymatous reticulum grows out radially in all directions, either accompanied by the epitheca or shooting out beyond it. The elements of the reticulum all stream outwards, and are either bandlike or filamentous. In the former case, the bands appear from their vertical position to be the remains of the laminate costæ which, we assume, at one time surrounded the calicles. The older portions of the corallum commence to thicken, the tissue for the purpose being supplied by threads of the streaming reticulum just mentioned, which bend sharply upwards and downwards, so that three layers are ultimately distinguishable :—(1) The middle streaming layer; (2) the lower layer, in which the threads are bent downwards; (3) the upper layer, in which the threads are bent upwards. The middle streaming layer always forms the growing edges, or, in branching specimens, the tips of the branches, and the calicles first appear in it.

The lower layer, formed by the threads bent downwards, seldom develops to any thickness. It often becomes very dense, or even, when covered over externally by the epitheca, quite solid. The calicles, bent down with it, often protrude slightly, apparently because the layer is not deep enough for them.

The uppermost layer is that in which the chief characteristics of the genus appear. Before describing them it is necessary to state that in branching types, the axis of a branch is formed of the middle streaming layer, and the bending outwards of its threads radially in all directions forms a thickening cortical layer which may be perfectly symmetrical and not distinguishable into an upper and a lower. This cortical layer shows all the typical variations seen in the uppermost layer of explanate and massive forms.

We may enumerate the following specialisations of this important thickening layer :—

(1) *Glabrous.* The threads bent upwards grow without any change in their simple

reticular arrangement, and all mounting equally, merely thicken the corallum. The calicles, which also bend upwards, open on the level surface.

(2) *Foveolate.* The reticulum may grow upwards faster than the calicles, in which case, the interstitial spaces swell up as ramparts round the calicles, which consequently appear to open in the bases of depressions or even of deep pits.

(3) *Papillate.* The reticulum may grow faster than the calicles, but irregularly, so that the interstitial spaces shoot up into papillæ of all sizes and shapes, and in many different relations to the polyp cavities.

(4) *Tuberculate.* Those threads of the thickening reticulum which stand at right angles to the middle streaming layer become differentiated from the rest; they straighten and thicken, so that a vertical section of this layer, but of this layer alone, reminds one of the trabecular cœnenchyma of *Porites*. All stages of this trabecular formation from the undifferentiated reticulum can be traced. These trabeculæ then rise above the interstitial spaces as spines and cylindrical tubercles of different heights and variously arranged. The trabeculæ, indeed, may be looked upon as in reality the thickened submerged bases of protective surface tubercles.

These, then, are the four primary divisions of the Montiporæ as here classified. They shade off into one another, the glabrous into the foveolate, the foveolate into the papillate, owing to irregularities in the heights of the ramparts, and the papillate shade off into the tuberculate by the diminution in the size of the papillæ till they are but thickened single threads. The specialisations are nevertheless quite clear and distinct.*

Under each of these heads we may have any kind of growth, explanate, massive, or ramose—indeed the same species in some cases appears under all these forms.

* A word of explanation is necessary as to the restricted uses of the terms papillate and tuberculate here adopted. It was found absolutely necessary to distinguish between the papillate uprisings of the reticulum of the interstitial spaces and the smaller solid spines rising from single trabeculæ. The importance of this cannot be overestimated; for in the types hitherto recorded, it is, at least in many cases, impossible to tell from the description what was the true character of the papillæ mentioned. The old Montiporan type, *papillosa* de Blainville, seemed to justify the limitation of the word "papillæ" to the swellings of the reticulum as such. What, then, should the smaller and more solid protuberances rising from single trabeculæ be called? In selecting the word "tubercle," the present author was guided by certain indications which seemed to point to these being the "tubercules" which characterised Lamarck's *Porites (Montipora) tuberculosa*. He writes: "Ces tubercules graniformes ou columniformes dont sa surface est parsemée'; and again says, that the interstices between the polyps of Ellis and Solander's *M. foliosa* are not "hérissées de tubercules" ('Animaux sans Vertèbres,' 2nd ed. ii. (1816) p. 272. I think it must be admitted that these terms are more applicable to the "tubercles," as the word is here used, than to the large papillæ. As a matter of fact, examination of Lamarck's types, preserved in the Paris Museum, shows that they were small cylindrical papillæ (see *M. tuberculosa*, p. 112) and not true tubercles as here defined. It is, however, of no consequence whether one's reasons for adopting a term are sound or unsound, at least in a case like this; while, on the other hand, it is a great gain to have, for the future, clearly defined meanings attached to the words used in the descriptions.

The Calicles.—In the formation of the colony, the budding and arrangement of the calicles are quite overshadowed by the profuse development of the cœnenchyma. While this ordinarily subordinate tissue runs riot, the calicles remain minute and insignificant like the living polyps which inhabit them (see above, p. 7). The genus presents us with a striking example of the subordination and degradation of the individuals for the sake of certain advantages to be gained for the colony. They, the individuals, remain at a peculiarly low level of development among the Madreporarian polyps, while, on the other hand, the stony colonies to which they give rise, stand high in their class for variety and beauty of form, and perhaps excel all others for plasticity in accommodating themselves to almost any method of growth.

The calicles are then peculiar on account of their small size and the characteristically stunted condition of their septal apparatus. They are seldom more than one millimetre in diameter, and may be so small as to be invisible to the naked eye (e.g. *M. porosa*, Pl. I. fig. 4)

The septal apparatus very rarely consists of more than two cycles, of which the secondaries are, as a rule, rudimentary. More than two cycles may be found in double calicles, an abnormality which is rare in *Montipora* but common in *Turbinaria*.

The septa themselves are typically vertical rows of septal spines. Occasionally, however, a few rather more conspicuous primaries (often only the directives) may be either continuously or interruptedly laminate.

The tips of the septal spines occasionally unite some distance down in the fossa to form a columella-like body (e.g. *M. Ellisi*), but this is certainly not typically the case, as Martin Duncan supposed. There are no known species with pali.

As we have already seen, the calicle wall, meaning thereby the ring of cœnenchyma immediately enclosing the polyp cavity, does not typically protrude above the surface of the cœnenchyma as is the case in *Madrepora*, *Turbinaria*, and *Astræopora*. On the contrary, the cavity opens either level with the surface of the cœnenchyma, or else is immersed by the regular or irregular swellings of the latter or by its crowds of tubercles.

There are, however, certain partial exceptions to this rule. For instance, whenever the special layer of the cœnenchyma in which the calicles are imbedded is thin, then the calicle may open in the centre of a mound. This is most commonly seen on the under surface, but also, in very thin explanate corals, on the upper surface also. This primitive condition is retained in the allied genus *Anacropora*, see p. 168.

There are, however, two kinds of false-calicle formation, which may at times assume striking superficial resemblance to the typical protuberant calicles of *Madrepora* and *Turbinaria*. The first is a specialisation of the foveolate rampart formation; groups of such ramparts rise higher than the rest, and fresh calicles open on the highest points and often appear like true protuberant calicles (see *M. caliculata*, p. 57).

The second occurs in the tuberculate group. The ring of tubercles immediately surrounding a calicle may be arranged so close to one another as to appear like a protuberant calicle wall. The actual aperture of the calicle is, however, generally in the base of the pit

formed by this rampart of tubercles. But that the polyps can move up higher within these pits is also certain from the occasional appearance of true septal spines projecting irregularly from the inner faces of the tubercles.

The Budding.—The budding in *Montipora* takes place at the growing edges of explanate forms, or in the tips of the branches in ramose forms, the young appearing in the middle streaming reticulum which alone comes to the surface at these places. In massive forms the young appear anywhere where there is room between existing calicles. A radial section of an explanate Montiporan has a certain resemblance to that of a Turbinarian. But in *Montipora* the polyps developing on the growing edge not only bend upwards as in *Turbinaria*, but also, if there is no epitheca accompanying the growing edge, downwards, which is not typically the case in *Turbinaria*. Starting, then, from a young colony with a parent polyp and its ring of daughters ranged radially in the saucer-like epitheca, these latter in lengthening give off buds in the direction of the growth of the colony, which may bend upwards or downwards. Those which bend downwards are generally sooner or later covered over by the advancing epitheca. If the corallum thickens greatly so as to be massive fresh buds appear between the existing calicles. We may again, then, say of *Montipora* what was said of *Astræopora*, that the budding appears to be indefinite and free, i.e. no such regular order is apparent as can be postulated for *Madrepora* and *Turbinaria*.

In this connection, the fundamental difference claimed by Ridley (op. cit.) between the Madreporinæ and the Montiporinæ, viz. that the former bud centrifugally and the latter centripetally, deserves comment. A wider survey than was then possible shows it to be too limited a distinction to be of any use. The budding in all the Madreporidæ takes place laterally out of the porous walls of the polyps. It is only in the genus *Madrepora* that certain larger polyps shoot upwards and show what Ridley called the centrifugal method of budding. On the other hand, the budding round the edge of the cup of a Turbinarian is in every essential like that round the edge of an explanate or foliate *Montipora*, viz. from the outer walls of the last formed polyps.

IV. AFFINITIES OF THE GENUS.

As above noted, the position assigned to this genus has oscillated between two families. Dana (op. cit.) suggested that *Montipora* might be deduced from *Madrepora* by the degeneration of the protuberant calicles, while Milne-Edwards* thought that they were Poritidæ characterised by special abundance of the cœnenchyma.

Taking this latter suggestion first, we find that the reason assigned for it is the "trabecular" structure of the corallum and chiefly of the septa. These, it is contended, leave no doubt as to the true affinity of the genus, in spite of its having certain form relations ("quelques rapports de forme") with *Madrepora*.

* Ann. Sci. Nat., (3) xvi. (1851) p. 54.

According, however, to the description above given (§ Morphology), the trabeculæ of the Montiporæ are not true trabeculæ, but are purely secondary productions correlated with the formation of protective tubercles on the surface. As the corallum thickens the protective tubercles are gradually submerged, and appear in sections as though they were trabeculæ.

It is obvious that the whole question of the relation of *Montipora* to *Porites* turns primarily upon this point: Are the trabeculæ of the former primitive or secondary?

They are here unhesitatingly claimed as secondary, for the following reasons :—

(1) They are always associated with the tubercles which are purely specialisations of the surface.

(2) They in no case extend through the corallum down to the epitheca, but are developed in the uppermost thickening layer, the stroma of which is arranged at right angles to that of the more primitive streaming layer.

(3) All stages of their formation can be traced from the straightening of certain threads of reticulum ending in fine surface echinulæ to the distinct trabeculæ projecting above the surface as stout tubercles.

(4) They only develop late in the growth of a colony, and are not found in very young forms, nor near to the growing edge.

(5) The great majority of the known types show no trace of this formation, being, like the youngest colonies, purely reticular.

These arguments, then, seem to the writer conclusive against classifying *Montipora* with *Porites*, for the trabeculæ, which appear to be primitive structures in *Porites*, are secondary specialisations in *Montipora*. Other arguments pointing the same way, based upon the method of budding, will be adduced in the volume dealing with the genus *Porites*.

The alternative relationship, according to previous writers, is that with *Madrepora*. *Montipora*, it was thought by Dana, might be deduced from Madrepores without distinct axial corallites by the degeneration of the protuberant calicles. On the other hand, it must be pointed out that there is certainly no evidence that *Montipora* ever passed through a Madreporan stage with its highly specialised method of budding.

The relationship with the Madreporidæ, however, can be established in a far more convincing manner by showing that all the genera can be deduced from a common parent form. This common ancestral form is not purely hypothetical, but can be practically demonstrated for three of the genera, viz. *Turbinaria*, *Montipora*, and *Astræopora*, while our views of the morphology of *Madrepora* require the assumption of a similar parent form.

The following are the chief characters of this common ancestral polyp :—

(1) The secretion of a thick porous wall built up of lamellate septa and costæ with their synapticular junctions.

(2) A saucer-shaped epitheca.

(3) Early budding from the walls of the polyp, i.e. while it was still comparatively small.

From such a form all the Madreporidæ can be deduced.

In *Madrepora*, the parent polyp shoots up, secreting a tall conical wall, from the sides of

which the porous walls of the daughters project in tiers, the parent polyp continuing to grow in height, and perhaps somewhat in size, while the daughters remain smaller and less highly developed.

In *Turbinaria*, the parent polyp shot up, but was soon smothered by the thick skeletal walls of its ring of daughters which grew out around it, as an axis, forming a disc or cup.

In *Astræopora*, the wall became specialised by the outer edges of the costæ forming long protective echinulæ; the budding took place laterally but without any definite order, so that representatives of this genus are typically massive formations.

In *Montipora*, the wall thickened at the expense of the polyp cavity, which thus remains at a very low stage of development. The laminate character of the septa and costæ was generally lost, and the wall became a plastic reticulum, in striking contrast to its rigid development in *Astræopora*. The budding of these very small but thick-walled polyps leads to the formation of stocks chiefly distinguished by the abundance and richness of their cœnenchyma.

The close relationship of *Anacropora* to *Montipora* will be discussed in the next section. The summary of the conclusions arrived at may be briefly anticipated:—While *Montipora* and *Anacropora* are closely united into a subfamily, the Montiporinæ, as already proposed by Ridley, the remaining three genera, *Madrepora*, *Turbinaria*, and *Astræopora* may also be united, by the common possession of protuberant calicles, into the subfamily Madreporinæ. The family Madreporidæ, as at present limited, contains these two subfamilies, the Madreporinæ, consisting of three genera, and the Montiporinæ, consisting of two genera.*

V. DIAGNOSIS OF THE GENUS.

Montiporæ, therefore, are Madreporidæ, in which the primitive lamellate septa and costæ of the walls of the individual polyps have melted down with their synapticular junctions, into a plastic reticulum. The cœnenchyma resulting from the fusion of the walls is richly and variously developed, especially for the formation of protective papillæ, tubercles, and ridges. The polyps are correspondingly small and feebly developed. The tentacles (twelve in number) are little more than papillæ, and the septal skeletal apparatus consists chiefly of vertical rows of spines present in two cycles, the second of which is typically rudimentary.

VI. GEOGRAPHICAL DISTRIBUTION.

The representatives of the genus *Montipora*, which deserve to rank high as reef-builders, extend from the Red Sea throughout the whole Indo-Pacific region as far north as the Loochoo Islands, China Seas, and southwards to the Barrier Reef; a single type (*M. fragosa* Verr.) has been recorded, with, however, a note of interrogation, as far east as the Gulf of California.

* These relationships will be found more fully discussed and illustrated in the Annals and Mag. Nat. Hist., xx. (1897) p. 117.

There is no record of any *Montipora* occurring in the Atlantic or West Indies. The *Manopora compressa* "from the Mediterranean"* is due to a wrong identification by Esper of a true Montiporan with the *Millepora compressa* of Linnæus.

VII. A GENERAL REVIEW OF THE VARIATIONS PRESENTED BY THE REPRESENTATIVES OF THE GENUS.

Variations in growth-form.—Every possible form of stock occurs in this genus,—foliate, massive, ramose, &c.

That some systematic value must be attributed to growth-form, no one who has handled many specimens of one and the same type can doubt. Certain definite specialisations of the cœnenchyma are apparently more consistent with one particular growth-form than with any other, e.g. *M. verrucosa* tends to form flat solid masses; but at the same time, irregularly branched forms may occur. Other cœnenchymatous specialisations seem to be consistent with almost any shape of corallum, and in these cases growth-form fails as a character of importance.

In spite, however, of these difficulties, certain lines of distinction exist, e.g. the thin foliaceous method of growth is sufficiently marked to be useful.

Although, therefore, the fact that the great plasticity of the cœnenchyma undoubtedly depreciates the taxonomic value of growth-form, yet it has a real value which, though it cannot yet be defined, cannot be ignored.

One modification of growth-form illustrated by the Collection deserves to be mentioned, viz. that of the detached and rolled fragment. The profusion with which different types throw up knobs and branches inevitably results in some of these being broken off. Of these detached fragments, some at least do not reattach themselves to the substratum, but yet may go on growing. Such free fragments of three different types occur in the Collection, and show remarkable similarity in their methods of adaptation. Two of them (*M. multiformis* and *M. indentata*) tend to form globular masses of short branches with rounded tops radiating outwards in all directions from a common centre; on the tips of these branches the specimens appear to have rested (see *M. multiformis*, Pl. VI.). In the third (*M. caliculata*) the mass was heavy, but the tendency of the upper surface to cover itself with short upgrowths is quite distinct. While in this last case the affinity is clear, in the former cases, but for the presence of transitional forms, both would have been classed as new species.

Variations in the calicles.—Owing to the feeble development of the polyps, the variations in size of the calicles are confined to very narrow limits. The number of septa is also very uniform, though the different degrees of development of the two cycles are important. One septum, or two opposite primary septa, are frequently greatly developed as directives. These,

* Dana's Zoophytes, p. 494.

as also large primaries, may be lamellate. The septa of the first cycle are often very exsert. Fusion in the base of the cell of the spines or edges of the septa, especially of the directives, occasionally takes place. In rare cases, the septal spines may fuse into or with a body which has all the appearance of being a solid columella (see *M. Ellisi*). Martin Duncan's statement that the calicles are typically provided with a columella is quite incorrect. Nor are there any pali.

The character of the margin is also a point worth attention: it may be sharply defined or else a mere irregular break in the reticulum. The calicle may have a flat rim round it, or its inner wall may be continuous with the sides of the surface papillæ, or ring of tubercles surrounding it.

While true protuberance of the calicular wall very seldom occurs in *Montipora*, all kinds of papillæ occur, as hoods, underlips, and so on, on which or under which calicles may open.

Variations in the cœnenchyma.—The chief surface specialisations in this have already been described. There are four variations, quite distinct and yet shading off into one another in the following order: glabrous, foveolate, papillate, and tuberculate (for details see above, p. 8).

For purposes of classification, I have found it necessary to include some of the transitions and to establish five divisions with sundry subdivisions.

I. Glabrous, in which the surface is smooth.

II. Glabro-foveolate, in which the foveolate appearance is not very marked, or perhaps only confined to the younger portions of the stock where growth is very rapid.

III. Foveolate, in which the interstices swell up into continuous or interrupted ramparts.

IV. Papillate.

(*a*) In which the interstices swell up in irregular patches.

(*b*) In which the papillæ form hoods or underlips, &c., to the calicles.

(*c*) In which the papillæ run together to form ridges.

(*d*) In which the papillæ form regular rounded or nipple-shaped swellings.

V. Tuberculate.

(*a*) In which the tubercles are distinct.

(*b*) In which the tubercles run together to form thin keels or ridges.

The systematic value of the various developments of these leading divisions is often very puzzling; as is also the value to be placed upon the variations in the fine texture of the surface itself, which may be delicately or densely reticular, flaky, woolly, velvety, echinulate, granular, and so on. For it is to be noted that the phenomenon mentioned in the preface to the Catalogue of the genus *Turbinaria* (Vol. II. p. 18) is equally apparent in this case. Certain types of surface texture and colour seem to characterise certain areas. The groups of specimens from New Guinea, from Tonga, from the Macclesfield Bank, from Houtmans Abrolhos, have in each case a curious resemblance to one another, due entirely to some subtile surface character, which cannot be easily laid hold of.

Important as are the surface characters, macroscopic and microscopic, of both upper and under surfaces, vertical sections through the corallum yield points of almost equal value. The middle streaming layer comes to sight. This, it is here suggested, represents the direct outgrowth of the reticulum into which the primitive radial skeletal structures of the ancestral parent polyp degenerated. It is, therefore, in a way the most primitive layer of the cœnenchyma. It can be seen at the growing edges and at the tips of branches, but in sections, its real thickness and character (dense or loose) can be gathered. It is sometimes a mere filamentous reticulum, at others it retains a trace of the old septal or costal lamellæ out of which it has developed. In this latter case, its elements are band-like, the bands streaming outwards and fusing to form anastomosing canals with perforated walls. Seen in cross section, the edges of the bands form delicate line patterns. In branches, the middle streaming layer becomes the reticulate axial strand, and shows the same variations in coarseness and texture.

The lower layer of cœnenchyma, which arises by the bending downwards of threads of the middle streaming layer, shows a few variations, which, however, on account of its lesser development, are not so important as those seen in the upper layer. In this latter layer vertical sections reveal the stages of variation, from pure reticulum to palisades of stout trabeculæ.

Variations in the epitheca.—The extent to which this important element in the coral skeleton is developed varies greatly : it may either follow the edge regularly with its growth from the earliest saucer-shaped young colony to its widest expansion, or else it remains behind and the corallum shoots freely out beyond it. Its variations in thickness and degree of concentric wrinkling have also perhaps a systematic value. In thin growths, the cœnenchymatous reticulum in immediate contact with it often changes into a solid layer fused with it, so that the epitheca as such is not distinguishable in section.

VIII. CONCLUDING REMARKS.

In grouping these variations under so many specific headings, it will be seen that I have selected those presented by the cœnenchyma as of the greatest importance. It is, of course, somewhat bold to rely upon so variable a tissue ; and yet, one has no choice. If the diagnosis of the genus above given is correct, the Montiporæ are specialised by the great development of the cœnenchyma, hence its variations alone can form the basis for a natural classification.

While, however, there can be little doubt that the leading cœnenchymatous variations supply us with very good characters, one's confidence fails on coming into the region of the finer surface markings. It is especially in these that the accidental variation is so great, and we can thus have no hope of finally classifying the genus until we have much larger series, enabling us to eliminate the chance and accidental variations from the more far reaching and important structural variations.

While claiming, then, that the chief divisions of the genus are natural divisions, I can only repeat what was said in the preface to Vol. II. as to the real value of the specific divisions. The types represent merely the more marked variations presented by the specimens in the National Collection, and are, therefore, for the most part purely artificial groupings. Only in those cases in which the individual specimens are known to have been collected from the same locality, and might almost be fragments of one and the same colony, does the name imply the close blood-relationship which the word species should be taken to connote. In all other cases, the types are, strictly speaking, only morphological groups, united because of certain peculiarities of form or structure which they have in common. Their ultimate systematic value is thus problematical. How much this is the case, indeed, may be gathered from the fact that the differences presented by specimens which are undoubtedly specifically identical may be far more striking than those that separate many of the types.

The influence on the mind of the puzzled worker of such a group of many individuals showing great variations yet undoubtedly specifically identical leads him as a rule temporarily to a wholesale lumping of other specimens, until his courage fails him, when the more striking individual variations are once more separately described as new types.

LIST OF SPECIES OF THE GENUS MONTIPORA.

(An asterisk implies that the species is not represented in the Collection.)

I. Glabrous.

(*a*) explanate.

1. exigua.
2. subtilis.
3. granulosa.
4. stratiformis.
5. explanata.
6. tenuissima.
7. porosa.
8. reticulata.
9. crassi-reticulata.
10. pallida.
11. punctata.
*12. complanata.
13. auricularis.
14. exserta.
15. glabra.

(*b*) rising into lobes.

16. obtusata.
17. bolsii.
*18. erosa ?
19. solida.
20. spongodes.
21. divaricata.
22. mollis.

(*c*) ramose.

23. levis.
24. compressa.
25. alcicornis.
26. fruticosa.
27. spicata.
28. rubra.
29. superficialis.
30. nana.
31. digitata.
*32. tortuosa.

II. Glabro-foveolate.

33. ramosa.
34. rotunda.
35. spatula.
36. marenzelleri.

III. Foveolate.

37. libera.
38. turgescens.
39. foveolata.
40. socialis.
41. caliculata.
42. calcarea.
43. irregularis.
44. multiformis.
*45. angulata.
46. gaimardi.
47. indentata.
48. palmata.
*49. rigida.
*50. limitata.

IV. Papillate.

(*a*) papillæ irregular.

51. venosa.
52. spumosa.
53. ænigmatica.
54. brueggemanni.
55. lanuginosa.
56. flammans.
57. lobulata.
58. edwardsi.
59. acanthella.
60. fungiformis.

(*b*) papillæ as hoods or underlips.

61. bilaminata.

62. guppyi.
63. tubifera.
64. crista-galli.
65. gracilis.
*66. spongiosa.
*67. circumvallata.
*68. stalagmites.

(*c*) papillæ in series.

69. papillosa.
70. denticulata.
71. pulcherrima.
72. prolifera.
73. australiensis.
*74. patinæformis.
75. undata.
76. viridis.

(*d*) papillæ nipple-shaped.

*77. planiuscula.
78. mæandrina.
79. danæ.
80. verrucosa.
81. ambigua.
82. mammifera.
83. sinensis.
84. abrotanoides.
*85. fragosa.
86. tuberculosa.

V. TUBERCULATE.

(*a*) tubercles simple.

87. perforata.
*88. scabricula.
89. variabilis.
90. annularis.
91. stilosa.
*92. villosa.
*93. nodosa.
94. mammillata.
95. cactus.
96. incrustans.
97. stellata.
98. inconspicua.
99. challengeri.
100. listeri.
101. grisea.
102. minuta.
103. lichen.
104. scutata.
105. peltiformis.
106. granulata.
107. æquituberculata.
*108. expansa.
109. incognita.
*110. phrygiana.
111. informis.
112. hispida.
*113. tuberosa.
*114. monasteriata.
115. friabilis.
*116. aspera.
117. fragilis.

(*b*) tubercles in ridges, &c.

118. rus.
119. crassituberculata.
120. amplectans.
*121. patula.
122. effusa.
123. frondens.
124. trabeculata.
125. ellisi.
126. efflorescens.
127. fimbriata.
128. solanderi.
129. striata.
130. circinata.
131. foliosa.
132. crassifolia.
133. plicata.
134. hirsuta.
135. bifrontalis.

SYSTEMATIC ARRANGEMENT OF THE SPECIES.

Group I.—GLABROUS.

a. Explanate.

1. **Montipora exigua.** (Pl. XXXI. fig. 1.)

Description.—Corallum thin (1 mm.), explanate, spreading in small patches either encrusting or arching freely over previous growths or over other corals, helping with other explanate Montiporans to build up a thick loosely laminated crust (cf. *M. bolsii*). An epitheca closely accompanies the growing edge.

Calicles visible as faint specks, 0·3 to 0·5 mm. in diameter, about 1 mm. apart. In younger, thinner portions with thin, prominent, but very irregularly developed septa, parts of two cycles; but in the older, thicker portions, the septa become stouter, one (directive) being much thicker and coarser than the rest. The fossa is inconspicuous.

The cœnenchyma consists of a flaky reticulum, the fine points from the edges of the flakes forming septa, in the younger specimens. In these, also, a flaky reticulum forms the upper surface: it may be said generally that the flakes lie horizontally, but their edges are turned up at all angles. In the older portions, the flaky reticular layer, of which the younger stocks entirely consist, sends up longer and thicker points. These, rising above the surface, form, with the flaky reticulum, a coarsely granular porous surface.

There are two specimens. One (*a*) consists of two small patches forming part of a laminated crust mainly composed of dead leaves of *M. bolsii* (see p. 34). The other specimen (*b*) is the minute young stock described in the Introduction, p. 7, and figured on pl. ii. vol. xx. of the Ann. and Mag. Nat. Hist. This was picked off the same mass of dead crust to which specimen *a* still adheres. There is no actual proof that these three stocks belong to one another. The two larger patches appear to be joined by dead coral in a way which makes it difficult to doubt their being the same, while the differences between them seem to show that the smaller may well be a transition form between the larger and the minute stock described in the Introduction. The chief change seems to be that the flaky reticulum which in the younger stages forms the whole cœnenchyma, becomes covered in the older specimens with a layer which is coarsely granular at the surface, as shown in Pl. XXXI. None of the specimens show sections.

a. Billiton, on dead *M. Bolsii*. (Part of) 83. 7. 24. 103. (Type.)
b. Minute young stage, Billiton.

2. **Montipora subtilis.** (Pl. XXXI. fig. 2.)

Description.—Corallum thin, 1·5 mm., explanate, encrusting, edges partly expanding and partly drooping. A well developed epitheca follows the growing edge.

Calicles visible as minute dark specks, 0·5 mm. in diameter, very irregularly differentiated from the surrounding cœnenchyma, scattered over the surface, 2 mm. and more apart. The septa, six or more, are very irregular, often mere surface granules slightly lengthened radially. The fossa is deep and conspicuous, rendering the calicles just visible to the naked eye.

Cœnenchyma in section a close granular reticulum throughout, forming a dense layer resting on the epitheca. At the surface the granulation is very fine and delicate, looking quite smooth to the naked eye. It shows a tendency (cf. *M. granulosa*) to form patches of coarse solid reticulum at the surface without any granules.

There is only one small encrusting specimen (with broken edges). It measures 6 by 3 cm., but its size is quite sufficient, in view of the extremely minute calicles, to justify its being ranked as a grown stock. The specific name is suggested by the fineness of the surface texture as seen by the naked eye.

a. Providence Reef, Mascarenes, sand and dead coral. H.M.S. 'Alert.' (Type.)

3. **Montipora granulosa.** (Pl. I. fig. 2; Pl. XXXI. fig. 3.)

Description.—Corallum spreads as a thin sheet (1 to 2 mm. thick) over the substratum which consists of dead growths of the same, here closely following the irregularities of the surface, there arching freely; on reaching the edge of the substratum the stock droops, and shows no tendency to grow out freely in the horizontal plane. An epitheca follows the creeping edge.

Calicles inconspicuous, 0·75 mm. in diameter, the aperture differentiated from the surrounding cœnenchyma chiefly by the radial arrangement of the coarse septa which nearly fill up the fossa. Irregularly scattered, some 3 mm. apart. Six well developed primaries with occasional appearance of smaller and thinner secondaries. The aperture is not sharply bounded, but the septa are merely enlarged radially arranged granules such as those which cover the surface of the corallum. Here and there the calicles appear to open irregularly on slight mounds of coarse reticulum.

The cœnenchyma consists of a coarse open-meshed reticulum which rests upon the epitheca, forming in immediate contact with it a dense solid layer distinguishable from the epitheca by its glassy appearance. The upper surface is covered by the slightly projecting granular ends of reticular threads. Where the stock is increasing rapidly in thickness, the

vertical elements of the reticulum form thin, short, very distinct trabeculæ. The projecting granules all reach the same level, and are of about the same size, although quite irregular in shape; having a whitish appearance, they give a soft velvety sheen to the whole surface.

The single specimen covers an irregular surface 11 by 7 cm., and appears to differ from *M. subtilis* chiefly in the greater coarseness, i.e. size, of all its elements.

a. Macclesfield Bank, China Seas, 44 fathoms. H.M.S. 'Rambler.' (Type.)

4. **Montipora stratiformis.** (Pl. I. fig. 1; Pl. XXXI. fig. 4.)

Description.—Corallum explanate, encrusting, 3 to 4 mm. thick, without conspicuous free edges; each new growth closely covers over the preceding, the edges drooping down. An epitheca follows the advancing edge.

Calicles minute, 0·4 mm., conspicuous as deep black punctures of irregular shapes. Only a few thick primary septa appear round the aperture, the complete cycles, primary and secondary, being seen only lower down, the secondaries much less developed than the primaries. The interseptal loculi are not sharply bounded, but open all round irregularly to the spaces of the cœnenchyma; hence, the broken margin of the aperture. The few large primaries appearing round the aperture are simply thick ends of the open surface reticulum.

The reticular streaming layer of the cœnenchyma is well developed and rests ventrally on a solid layer of varying thickness in contact with the epitheca. The upper thickening layer tends to have its vertical elements slightly thickened, but they do not form trabeculæ. The free tips of these elements do not appear to project freely above the surface, but on shooting above the levels of the calicles, they are joined together by horizontal threads. These threads, running from point to point and twisting at all angles, give rise here and there to an arabesque pattern. We have thus the thickening corallum with a surface layer of loose open reticulum threatening to submerge the polyps, whose full cycles of septa always remain below the irregular aperture.

There is only one specimen which appears to be perfect. It is a massive block, 3 cm. thick and 6 cm. long, which has been built up by successive growths of this same coral; at least three distinct layers of the same size can be easily distinguished; below these, the coral is so corroded and tunnelled through by other organisms that it is difficult to recognise. The two lower of the three uppermost layers are thicker than the uppermost, which, as we have seen in the description, was evidently thickening. It appears, then, here as if we have the greater part of the history of a Montiporan stock. The colony, after building up a certain thickness of cœnenchyma (which latter, as is typical of the group, grows faster than the polyps lengthen) dies down and a fresh layer of polyps covers it over.

Not only is the surface covered with young Balanids, but certain organisms (? boring Molluscs) have their tunnels running through the whole series of layers, and have in some way hindered the uppermost living layer from growing across the mouths of their holes.

a. New Guinea. Vienna Museum. (Type.)

5. **Montipora explanata.** (Pl. I. fig. 3; Pl. XXXI. fig. 5.)

Montipora explanata, Brüggemann, Phil. Trans., clxxiii. (1879) p. 577.

Description.—Corallum explanate, 7 to 8 mm. thick, smooth, with wavy surface; growing edge 2 mm. thick, not supported by epitheca, which is developed only in patches. The stout corallum grows over former growths, spreading evenly from elevation to elevation, leaving large free spaces underneath.

Calicles crowded, from about one diameter apart; aperture 0·75 mm. Septa irregular and feebly developed, except one primary which is often prominent and exsert. On the under surface, the calicles are numerous, irregularly distributed, the smallest being minute pinholes without septa, only here and there the single large primary faintly indicated.

Cœnenchyma, in section, shows the typical streaming reticular layer which passes ventrally into a very dense, often quite solid layer pierced by the ventral polyp cavities, and dorsally into a closely knit thickening layer, often sharply marked off from the horizontal layer. The vertical elements of this bent up layer are here and there almost as regular as trabeculæ, but they are not thickened or otherwise differentiated, and the layer is truly a reticulum. On the surface, the level interstitial spaces consist of a very coarse granular reticulum.

The type specimen was first briefly described by Brüggemann in an account of new coral species from the Red Sea and from Mauritius.* He did not name it, however, as he was not certain whether it might not be the *Manopora lichen* of Dana. As there can be no question about the total absence of anything like "subtubiform protuberant calicles" such as are described by Dana for his *M. lichen*, Brüggemann, in working out the corals from Rodriguez, dismissed this suggested relationship and united it with two others from that locality under a new name "*explanata*."

Brüggemann further compared this specimen with Dana's *M. scabricula*. The two may agree in general appearance, but the vertical threads of the thickening layer show more tendency in the latter coral to rise up as minute tubercles above the surface of the cœnenchyma; and further, from Dana's drawing of a section of that type,† these vertical elements form stout trabeculæ at considerable distances from one another—a condition in marked contrast to that shown by a section of *M. explanata*.

The two specimens from Rodriguez, classed with this coral by Brüggemann as *a* and *b*, also have the vertical elements of the thickening layer differentiated into stout trabeculæ and are thus placed elsewhere (cf. *M. perforata* and *M. venosa*).

The single type specimen is much distorted on the upper surface by commensal Balanids.

a. Mauritius. (Type.)

*Abh. Nat. Ver. Bremen v. (1878) p. 399. † Cf. Zoophytes, pl. xlvi. fig. 3*c*.

6. **Montipora tenuissima.** (Pl. I. fig. 5; Pl. XXXI. fig. 6.)

Description.—Corallum very thin, from 1 to 1·5 mm. thick, less than 1 mm. at the growing edge, irregularly horizontal, expanding over former growths, edges extending freely but supported by a well developed concentrically wrinkled epitheca which is conterminous with the growing edge. The epitheca is secondarily strengthened by a layer of dense matter deposited on its upper surface by the cœnenchyma. New growths arch here and there freely over the old.

The polyp cavities, which are irregularly distributed from 1 to 3 mm. apart, are minute, 0·75 mm. across, star-like, and somewhat conspicuous on the older and thicker portion of the corallum, but very much smaller on the thin fragile expanding edges. Owing to the extreme thinness of the stock the cœnenchyma is slightly raised round the polyp cavities, here and there into prominent and hemispherical mounds. Towards the edges the slightly raised apertures slope outwards. The six primary septa are prominent and exsert, one or two directives here and there still more prominent than the rest. Secondary septa not developed. The margin of the calicles quite irregular, the interseptal loculi running out into the open spaces of the cœnenchyma.

In section, the typical horizontal streaming layer is recognisable. It consists of a wide-meshed thread-like reticulum, being, in thin portions, some three meshes altogether in thickness. This reticulum forms a dense layer immediately in contact with the epitheca, while dorsally it gives rise in the older thicker portions of the stock to a thin layer of upright threads. These are thin and delicate, expanding, however, at intervals into thick nodes which fuse with those of the adjacent threads. The cœnenchyma on the surface is finely and evenly granular, the granules being very minute in the expanding portions of the stock where only the points of the streaming reticulum rise to the surface, but somewhat coarser in older encrusting specimens where the thickening layer is developed: in this latter case, they are the irregular knob-like or slightly branching expansions of the tips of the vertical elements of this layer.

There are three specimens united together under this heading. One is an irregularly oval specimen 4 to 6 cm. across (Pl. I.). It is encrusting a dead previous growth, but has one edge freely expanding. There is a marked contrast between the calicles on the thicker encrusting portion and those on the freely expanding portion. In the former situation the calicles are raised and conspicuous, in the latter they are hardly visible.

The other two specimens are fragments from the free edges of other stocks, and are accordingly very thin and fragile, and with inconspicuous calicles. The tendency of the cœnenchyma to form slight eminences round the polyp cavities in the extremely thin reticulum is, however, evident. There is no thickening layer in these fragments, and the surface is smooth and velvety. Both specimens have Balanids, and the larger one recumbent worm tubes as well, on their upper faces; over these the cœnenchyma sooner or later spreads. The smaller of

them is briefly described by Bassett Smith, who suggests its affinity with *M. lichen*.* But Dana's type had "subtubiform calicles" and was much thicker.

These are remarkable on account of the enormous depth at which they are found, and also because they are the thinnest and most delicate of all the known Montiporans.

a. Macclesfield Bank, China Seas, 35 to 41 fathoms.	Coll. Bassett-Smith.	(Types.)
b. Macclesfield Bank, China Seas.	„ „	
c. Macclesfield Bank, China Seas, 40 fathoms.	„ „	

7. **Montipora porosa**. (Pl. I. fig. 4; Pl. XXXI. fig. 7.)

Montipora porosa, Bassett-Smith, Ann. and Mag. Nat. Hist., vi. (1890) p. 451.

Description.—Corallum, complete form unknown, explanate, thin, translucent, with points of light passing through near the edge, expanding freely, of nearly even thickness, 2 mm., irregularly wrinkled, fine wrinkles running radially and a tendency to coarse wrinkling concentrically; unsupported by an epitheca.

Calicles hardly visible to the naked eye; with a lens, they show as minute (less than 0·4 mm.) inconspicuous star-like arrangements of the surface of the cœnenchyma, very irregularly scattered, at times far apart, here and there not more than 2 mm. from one another. In younger and thinner fronds, the calicles can be seen as minute dark points; these disappear with the thickening of the cœnenchyma. The septa are very irregular, projecting inwards from the ring of surface granules; sometimes the six primaries are distinct, at others there are more than six, but no clear distinctions can be made out between primaries and secondaries. The fossa appears quite shallow.

Cœnenchyma shows, in section, the outwardly streaming reticulum, which is loose, light, and open meshed, but much denser towards the under surface. There being no epitheca, the under surface is slightly porous and a few minute calicles open in it. The upper thickening layer is only slightly developed, the horizontal streaming layer forming the bulk of the thin corallum. The upper surface looks smooth and velvety to the naked eye, but is composed of evenly distributed granules, between which the pores are but faintly visible. There is a distinct tendency of the granules to run in series towards the growing edge. On the under surface, the granules are more minute and the pores are larger and more conspicuous.

There are three specimens which can perhaps be classed under this heading. The largest (*a*) is a fragment broken off from the growing edge of some stock, the complete form of which is unknown. Though some 7 cm. across and 10 deep, there is no trace of any supporting epitheca. Strength for so large an expanse of coral seems to be gained by concentric wrinkling, the edge hanging down and then turning up again. In the lower angles of the wrinkles the cœnenchyma tends to send down pendent drops.

* Ann. and Mag. Nat. Hist., vi. (1890) p. 450.

The next specimen (*b*) is a fragment of a still younger and thinner stock (Pl. I. fig. 4). It is the original specimen named *M. porosa* by Bassett-Smith, but it seems to me best to consider it as a younger stock of the coral just described. It agrees well with the description; it shows, however, only very slight traces of the concentric wrinkling which is pronounced in the older specimen. In this younger specimen there are traces of an epitheca, which, however, remains far behind the growing edge.

a. Macclesfield Bank, China Seas, 32 fathoms. Coll. Bassett-Smith. } (Types.)
b. Macclesfield Bank, China Seas, 35 fathoms. H.M.S. 'Rambler.' }

A third small fragmentary specimen which is so covered and distorted by Balanids as hardly to be recognisable. The general character of the corallum in the narrow strips between the infesting organisms suggests its affinity with the above.

?*c*. Macclesfield Bank, China Seas, 28 fathoms. Coll. Bassett-Smith. [93. 9. 1. 90.]

8. **Montipora reticulata.** (Pl. I. fig. 6; Pl. XXXI. fig. 8.)

Description.—Corallum explanate, freely expanding, with slightly wavy surface. Uniform thickness, 2 to 3 mm. The growing edge is alive for 5 to 6 cm.; centrally to this zone the coral dies away, and is covered by a white film. The epitheca is developed to about 1 cm. from the growing edge. Along the edge of the epitheca, the cœnenchyma tends to hang down in drops and rootlets, which are subsequently grown over by the epitheca.

The calicles are minute, 0·75 mm., fairly conspicuous; opening in the older parts of the stock on slight eminences, irregularly scattered from 1 to 3 mm. apart, and with apertures nowhere well defined. The septa are very irregular, mere thin threads of the surrounding reticulum projecting into the deep fossa; parts of two cycles, seldom complete. Calicles appear on the under surface, where it is not covered by epitheca.

The cœnenchyma consists chiefly of the outwardly streaming layer, which is laminate; its elements bend downwards to form a thin, dense layer resting on the epitheca, while the upper thickening layer is very slightly developed as a graceful thread-like reticulum, with the free thread-like ends bent in all directions; round the calicles they form the septal rods. In the dead central portions of the stock, the white film begins to form as so many small discs round these free ends.

There is only one specimen, the growth of which appears to be as follows. The thin explanate coral creeps steadily outwards and, like certain lichens, dies away posteriorly, and, while in the main free from the substratum, it drops rootlike knobs for support at intervals. These knobs always take place along the outer edge of the epitheca. The single type specimen shows three distinct rows of such knobs now covered up with epitheca. Most of them are but slight drops, but in the oldest row in the specimen one hangs down nearly 2·5 cm. in length.

The specific name refers to the light, open reticulum, not unlike that of a fine bath sponge, which covers the surface.

a. Macclesfield Bank, China Seas, 32 fathoms. Coll. Bassett-Smith. (Type.)

9. **Montipora crassi-reticulata.** (Pl. II. fig. 5; Pl. XXXI. fig. 9.)

Description.—Corallum explanate, freely expanding, uneven, horizontal, of nearly even thickness, 2 mm. at the growing edge, and 3 mm. at 6 to 7 cm. from the edge, supported by a well developed concentrically wrinkled epitheca, following about 2 mm. behind the growing edge.

Calicles minute, 0·5 mm., only faintly differentiated from the cœnenchyma. Septa with six well developed primaries and here and there rudimentary secondaries. Fossa deep.

The streaming layer of the cœnenchyma is a thin open reticulum. Its elements bend rather sharply downwards and upwards. In the former case, the tips end in a very distinct solid layer resting on the epitheca, and in the latter case they form short, thin, but closely packed vertical threads which may be straight and continuous, like trabeculæ. On the surface the cœnenchyma is a coarse open reticulum which is either naked or else covered with whitish granules, which are the jagged tips of processes rising from the coarse reticulum. The large meshes of the reticulum between the granules are conspicuous.

There are two specimens, both fragments. The larger (*a*) has been broken off from the expanding edge of some stock of unknown shape. It differs from all the other thin explanate Montipores from the Macclesfield Bank in the greater thickness of the corallum and in the coarseness of the surface reticulum. The upper surface is rendered very uneven, but the irregularities appear to be largely due to swarms of minute Balanids which are in all stages of burial by the surrounding cœnenchyma.

The smaller specimen (*b*) is a portion of an expanding growth which has spread over a former growth, beyond the edges of which it projects.

a. Macclesfield Bank, China Seas, 32 fathoms. Coll. Bassett-Smith. (Type.)
b. Macclesfield Bank, China Seas, 25 to 30 fathoms. " "

10. **Montipora pallida.** (Pl. II. fig. 2; Pl. XXXI. fig. 10.)

Description.—Corallum explanate (complete form unknown), of nearly uniform thickness, 2 mm. at growing edge, to 3 mm., with freely expanding edges, followed irregularly by an epitheca, here and there reaching the growing edge, at other times 5 mm. behind.

Calicles minute, visible to the naked eye as faintly raised whitish rings, 0·5 mm. in diameter and about 1 mm. apart. The appearance of white rings is due to the fact that the irregular septa with their tangential granular thickenings rise slightly above the level of the

surrounding cœnenchyma. The six primaries are generally well developed and between them the open interseptal loculi are often well marked, owing to the contrast presented by the closeness of the texture of the surrounding cœnenchyma. At a lower level, secondaries also appear, slighter than the primaries, but stretching well into the polyp cavity. The septa together nearly fill up the fossa, which is thus inconspicuous to the naked eye. Calicles appear on the part of the under surface which projects freely beyond the epitheca.

The cœnenchyma is dense. The horizontal streaming layer tends to solidify at a short distance from the growing edge. A solid basal layer rests on the epitheca. The upper thickening layer is also dense, its elements are often not distinguishable, and the whole surface, except where the streaming layer, round the growing edges, is still uncovered by any thickening layer, is almost stony in appearance, yet scurfy owing to the presence of fine flakes and hairy points.

There is only one specimen, which is a mere fragment. The calicle shown on Pl. XXXI. is quite exceptionally regular, the ring is more often interrupted and of uneven thickness. The fine hair-like processes on the apparently solid surface no doubt correspond with the surface granules on the types already described. These processes give the coral a pale whitish look which suggested the name; the black stains on the upper surface of the specimen may be natural or accidental.

a. Bassett-Smith Shoal, Holothuria Bank, 9 fathoms. Admiralty. (Type.)

11. **Montipora punctata**. (Pl. II. fig. 3; Pl. XXXI. fig. 11.)

Description.—Corallum explanate (complete form unknown), with free edge, about 3 mm.; from 5 to 6 mm. in thickness in the older parts. Edge not closely supported by the epitheca. The edge of the epitheca may be rolled back by the cœnenchyma.

Calicles numerous, like minute punctures in the smooth surface, ca. 1 mm. or less apart. Aperture 0·75 mm. in diameter, irregular; primaries often well developed, with one or two conspicuous directives, one of which is often exsert and laminate; the secondaries only feebly indicated. On the under surface the calicles are still more minute, but not so crowded as on the upper surface, and the solid ring round each aperture is thick and the septa short, coarse, and irregular. The calicles both above and below are rendered specially conspicuous by being stained a deep orange in contrast with the paler yellow of the cœnenchyma.

The cœnenchyma shows a very well developed laminate streaming layer, which expands upwards and downwards. In the former case, it gives rise to a thickening layer in which the vertical elements are very thin, thinner, indeed, than are the cross junctions which appear to run in more or less continuous lines parallel with the upper surface. The under surface is formed of a smooth, solid, flaky reticulum, the calicles opening in solid rings of the same. The upper surface is formed of a close granular network looking smooth to the naked eye; here

and there, however, the interstices show slight tendencies to surge upwards (as in *spumosa*). A few knobs are formed, apparently by such local surgings, but on the whole the surface is smooth and flat.

There is only a fragment, which I thought it possible at one time to unite with *M. explanata*, at another with *M. exserta*, but the differences on close inspection are in each case too great. In making a type of a small fragment, so broken that it gives hardly any indication of the method of growth of the whole, I should expressly state that this arrangement is only provisional. Such a fragment often shows interesting structural features, which deserve separate description, although it is highly probable that the acquisition of a few series of complete stocks would serve to unite many of such separate fragments together.

a. Albany Passage, Great Barrier Reef. Coll. Saville-Kent. (Type.)

12. Montipora complanata.

Porites complanata, Lamarck, Hist. d. Anim. sans Vert., ii. (1816) p. 272.
Montipora complanata, Milne-Edwards and Haime, Ann. d. Sci. Nat. (3°) xvi. (1851) p. 59.

Description.—Corallum explanate (complete form unknown), thin and nearly flat, 2 mm. thick at growing edge, 3 mm. at 6 cm. from the margin; the epitheca may reach the edge or be tilted back by a thickening of the cœnenchyma.

Calicles numerous, conspicuous, nearly equal in size and in distance apart, hardly 0·5 mm., seldom sharply defined all round. Six somewhat thickened but unequal primaries, which are mere irregular projections of the thick reticular threads; directives here and there visible to the naked eye; often rudimentary secondaries. Only a few calicles open on the under surface, except where the cœnenchyma has thickened and threatened to roll back the epitheca.

The cœnenchyma shows in section a very coarse but close streaming layer. The upper hickening layer is conspicuous because the vertical elements are almost trabecular, but are not much thicker than the junctions. The upper surface is irregularly and loosely spongy, without any definite features, the threads being coarse. On the under surface, which is fine and compact, the epithecal film is very thin, and shows all the tracery and granulations of the reticulum in relief.

Of the two specimens in the Paris Museum (245*a*, 245*b*), the former is undoubtedly the original *Porites complanata* of Lamarck, first identified as a Montipore by Milne-Edwards and Haime. In general appearance, the specimen somewhat resembles *M. exserta* of Quelch (see Pl. II. fig. 4), but it differs in the absence of the exsert septa of this latter species. Another probably close ally is *M. glabra*, see p. 32. This, indeed, may be specifically identical with Lamarck's type. The Paris specimen 245*b* is apparently a young leaf of one of the foliate

Montipores, the streaming layer rising in jagged flames above the surface, while near the base tubercles are formed.

Locality unknown (Coll. Lamarck, 1801), from the voyage of Péron and Lesueur. No. 245*a* in the Paris Museum. (Type.)

13. **Montipora auricularis.** (Pl. II. fig. 1; Pl. XXXI. fig. 12.)

Description.—Corallum (complete form unknown) explanate, thick, over 1 cm. thick at 7 cm. from the edge, the edge forming ear-shaped slightly drooping lobes, one over the other, with spaces between, merely touching and fusing here and there; growing edge of variable thickness, 4 to 5 mm., very friable. Very slight traces of an epitheca, in faint thin patches, far from the growing and drooping edge.

Calicles numerous, conspicuous, in the thicker parts of the corallum deep and open, with irregular margins of different sizes, the largest about 1 mm., less than 1 mm. apart, young minute calicles opening in the spaces between the older. The septa hardly developed at the margin, but deeper down six primaries are distinct, with one or two directives visible to the naked eye. Towards the growing edge, the calicle apertures are drawn out into ovals, each with a thin conspicuous white thread running round at least its proximal half. As a rule, the directives are the only traceable septa in these sloping calicles.

On the under surface, the calicles are similarly crowded, but distinctly smaller than on the upper surface, especially crowded and minute in the valleys, septa very irregular, but traces of two cycles of minute granular points; in the depths of these calicles, the septa seem to swell up into large knobs and granules, almost filling up the fossa.

Cœnenchyma has a very thick (ca. 5 mm.), light, laminate streaming layer which bends upwards and downwards. The vertical elements in both cases are fine threads, loosely arranged, and here and there almost like continuous trabeculæ. The ventral layer is thin and gives rise at the surface to a solid, stony-looking reticulum which gets looser and lighter towards the growing edge, where the streaming layer forms the whole thickness of the coral. The upper layer consists of a very light delicate network, which is quite level on the surface and appears to indicate rapid growth in thickness. At the thick growing edge the laminate but very porous streaming layer forms a delicate woolly reticulum punctured here and there by deep holes with membranous walls, i.e. by young calicles without any septa yet developed.

There is again only a fragment, 8 cm. deep and 1·5 cm. thick at the line of fracture. It is at first puzzling to know which is the upper and which the lower side; only experience of the usual methods of growth of *Montipora* enables one to fix with confidence on the side with the thinner but denser thickening layer with its smaller calicles as the lower. The method of growth, as suggested by this fragment, resembles that of a fungus from the trunk of a tree. Attached by their thick bases to some upright surface, horizontal, but slightly drooping and wavy fronds, one close above the other, may have projected. The growing edge varies in

thickness from 4 to 5 mm., and is formed of a beautiful white, foam-like reticulum, half filamentous and half laminate. Young calicles open here and there in its face as large round holes, with their apertures encircled by an irregular thread-like ring of thin cœnenchyma. The coral is spongy and light like a piece of pumice stone, reminding one of *M. spongodes*, with which, however, it is impossible to unite it (see p. 37).

a. Thursday Island, Great Barrier Reef. Coll. Saville-Kent. (Type.)

14. **Montipora exserta.** (Pl. II. fig. 4; Pl. XXXI. fig. 13.)

Montipora exserta, Quelch, Chall. Rep., Reef Corals (1886) p. 174, pl. viii. figs. 5, 5*a*, 5*b*.
Montipora scabriculoides, Ortmann, Zool. Jahrb., iii. (Syst.) 1888, p. 155; see also op. cit., iv. (Syst.) 1889, p. 499.

Description.—Corallum a free horizontal growth (complete form unknown) attaining a considerable size, 2 mm. thick at growing edge, 8 mm. or more near the centre of attachment. On the decay of the central region, the living layer may extend centripetally, so as to cover over the dead portion (see Pl. II.). The epitheca follows the growing edge at varying distances, from 2·5 cm. and less. It is thick and wrinkled when newly grown, but appears to get worn off in patches or greatly thinned.

The polyp cavities minute but conspicuous, 0·75 mm., evenly distributed, about 1 mm. apart, edges of the aperture not very sharply defined, each aperture to the naked eye as if bisected by a sharp white vertical plate, due to the presence of two very prominent septa which stretch across the half radius circle and moreover tend to rise above the surface of the interstitial cœnenchyma. Deep down in the cell, these sometimes meet, or again they are sometimes united by a central upgrowth (? a columella). The distal of these exsert septa, i.e. that nearer to the growing edge, is often higher than the proximal. These directive septa run at all angles to the growing edge, but very seldom parallel to it. The four remaining primary septa are very irregularly developed: sometimes one or two are pronounced, at others they are hardly distinguishable from those of the secondary cycle, all alike being thin and feebly developed. The polyp cavity is deep.

Cœnenchyma. In section, there is the typical streaming layer running straight out to the growing edge. It consists of broad thick bands and is very massive. Here and there, where parasites have bored through the epitheca, sheets of solid matter form within this layer. From under it a thin layer of finer threads bends down to form the under surface, grown over in time by the epitheca. Above it, a well developed layer of reticulum thickens the corallum and has its vertical elements only faintly suggestive of trabeculæ. It is more of a lattice-like reticulum of coarse texture and small meshes. The level surfaces of the interstices consist of irregular jagged flakes.

There is but one specimen, which appears as if it were a sector of a flat plate which may have been some 40 cm. in diameter. The portion of the centre of the plate which came away

with the fragment was dead, but was surrounded by a living zone about 20 cm. broad. The living zone was apparently growing back again over the dead portion. The surface of the whole is covered with recumbent worm tubes, and large and small Balanids, all of which are partially imbedded in the cœnenchyma.

a. Wednesday Island, Torres Straits (in two pieces). H.M.S. 'Challenger.' (Type.)

In 1888, Dr. Ortmann described a Montipore from Samoa, in the Strassburg Museum, under the name *M. scabriculoides*, but in 1889 he identified it with this species.

15. **Montipora glabra.** (Pl. XXXII. fig. 1.)

Description.—Corallum thin, free, horizontal, explanate, of nearly even thickness, 3 mm., at the growing edge 2 mm. Epitheca extensive, but irregular and in patches.

Calicles uniformly small, 0·50 mm., evenly distributed, about 1 mm. apart. Septa irregular, as mere pointed granules projecting over the edge of the aperture, six primaries being usually distinct. The second cycle partially developed.

Cœnenchyma in section an open, coarse reticulum, the streaming layer not very pronounced as it bends upwards and downwards very gradually to form the upper and lower surfaces. Where the lower layer rests upon the epitheca it solidifies. The upper surface is porous and granular to the naked eye, but is perfectly level, i.e. without interstitial uprisings.

There are a number of fragments of this coral from Torres Straits, which reveal nothing as to the method of attachment of the stock. It is very closely allied, if it be not specifically identical with *M. complanata*; the calicles on Lamarck's type are perhaps more crowded and the cœnenchyma coarser. Again, in general appearance, and in the fact that the streaming layer in both has been attacked by a boring sponge, the coral resembles *M. exserta* of Quelch, which is also from the Torres Straits. But the exsert directives are so marked a feature over the whole corallum in this latter type, whereas exsertness of the septa is only found in single calicles, and then not very marked in the specimens under discussion, that it is better to keep the two apart. Further, the corallum in *M. exserta* is much thicker, the upper perpendicular layer alone being 3 to 4 mm. thick. It is, however, quite possible that further specimens will establish the specific identity of these three forms, *M. complanata*, *M. exserta*, and *M. glabra*.

a. Torres Straits (in eight fragments). Prof. A. C. Haddon. (Type.)

b. Rising in lobes or branches.

16. **Montipora obtusata.** (Pl. XXXI. fig. 14.)

Montipora verrucosa, De Blainville, Man. d'Act. (1834) p. 388, and Atlas, pl. lxi. figs. 1 and 1*a* (*non* Quoy and Gaimard).
Montipora obtusata, Quelch, Chall. Rep. Reef Corals (1886) p. 174, pl. viii. figs. 3, 3*a*.

Description.—Corallum horizontal, plate-like, thick but transmitting light; the wavy round edges, 5 mm. thick, tend to bend up. All the free portions of the corallum supported on the under surface by a well developed concentrically wrinkled epitheca. The upper surface to the naked eye is smooth, but raised into thick, finger-shaped processes, which are in all stages of development from mere hemispherical or conical mounds up to knob-like excrescences 3 cm. high. These processes are irregularly scattered and tend to be taller near the centre of the corallum; here they may flow together to form irregular masses. The processes tend to slope slightly away from the vertical axis of the corallum. They are, to the naked eye, smooth and evenly studded with calicles like the rest of the upper surface of the corallum. At each new period of growth, the corallum spreads over a previous smaller growth, not always in close contact with it, but arching over it, supported on the raised processes so that there may be a space between the explanate portions of the successive coralla.

Calicles very minute, 0·5 mm. in diameter, open on the smooth surface of the corallum, at the tips of the processes hardly demonstrable; evenly distributed, 1·5 to 2 mm. apart, over the whole corallum, even round the growing edges and on the under surface where the latter is not covered with epitheca. Septa distinct but irregular, reaching beyond the half radius circle, and consisting of two cycles or parts of two cycles which are generally distinguishable from one another.

Cœnenchyma in section dense, with a thin, perfectly solid basal layer in contact with the epitheca. The streaming reticular layer is dense and composed of thick glassy threads; above this occurs a fairly thick layer of closely packed, nodulated, more or less vertical threads which hardly form distinct trabeculæ. The surface of the corallum is composed of flat, highly perforated branching flakes, the pointed edges of which, grouped together in a plane round the calicles, form the septa. This surface reticulum is close and solid on the lower level portions of the corallum, but light and open on the sides and slopes of the rising processes. At the tips of the processes, the texture alters, owing to the elements of the streaming layer, which here comes to the surface, projecting in all directions.

In establishing this species, Quelch appears not to have recognised that it is specifically identical with the coral figured by de Blainville in the Atlas to his 'Manuel' as the *Porites verrucosa* of Lamarck. Although de Blainville had the advantage of examining Lamarck's

types, his identification in this case is so far from correct that it looks as if some slip must have been made in the editing of his work (see the notes on *M. verrucosa*, p. 104).

On the other hand, there is no difficulty in identifying the 'Challenger' specimen described by Quelch as *M. obtusata*, with de Blainville's figure. This figure represents a younger growth with fewer and shorter processes, probably at about the same stage as the dead earlier growth seen under the specimen in the National Collection. Further, the enlarged figure of a calicle shows the reticular character of the cœnenchyma and the presence of two cycles of septa.

There is unfortunately only one specimen.

a. Fiji Reefs. H.M.S. 'Challenger.' (Type.)

17. Montipora bolsii. (Pl. II. fig. 6; Pl. XXXI. fig. 15.)

Description.—Corallum closely encrusting, 2 to 3 mm. thick, one growth spreading over another and over other corals, leaving great spaces, thus building up thick crusts of rock which are full of cavities. The living coral occurs in patches, the edges of which may grow out freely as lateral expansions; or, again, the surface of a patch may rise up and grow out freely into sloping flame-like masses which are solid and covered rather with small irregular points than with branches. A well developed epitheca follows the growing edge of all the creeping and freely explanate growths.

The calicles are minute, variable in size, 0·5 mm. and less, evenly distributed about 1 mm. apart, with deep conspicuous fossa surrounded by a ring of six pronounced and slightly exsert granulated septa; a second cycle present in the larger calicles, but very irregularly developed; the directives in the larger calicles often laminate.

The cœnenchyma shows in section a dense reticular layer, which appears to form a solid layer on the epitheca. The upper thickening layer is also dense; on the explanate portions of the stock it is thin and insignificant, but is well developed in the free branching portions. The surface of the thinner and younger portions of the coral is smooth, solid, but finely granular. In the older and thicker portion it is covered with minute flame-like points or granules which together give the whole surface a smooth, soft appearance. The appearance of the interstices is in marked contrast with the coarseness of the exsert septa.

The type specimen is an irregular mass of coral, mostly dead and corroded and full of hollows between the layers and the imbedded branches of former growths of this and of other corals. Minute saucer-shaped growths, many of which no doubt belong to this coral, are found on the under side. One, the smallest and youngest of these stocks, has been separately described in the Introduction as an early stage of *M. exigua*, which is found in large patches on specimen *b*. Small patches of a third type of *Montipora* (*M. inconspicua*) also occur on specimen *a*. In the thick flaming portion of the coral, the stars are very distinct and regular upon a smooth yellowish creamy ground; they are much less conspicuous on the duller looking younger patches. The whole mass of specimen *a* is 12 cm. long, and from one side of it (the left in the fig. 6, Pl. II.) the solid flaming portion streams out freely another 5 to 6 cm.

Specimen *b* is a portion of dead crust built up in the manner described. There are small patches of the thin encrusting *Montipora exigua* upon it, which appears to differ considerably from *M. bolsii*. It would thus appear that this hollow crust of *explanate* Montipores is built up of three distinct species, of which *M. bolsii* was, at the time of collection at least, in the most vigorous growth.

a. Billiton (with *M. inconspicua*). Coll. Bolsius. [83. 7. 24. 103.] (Type.)
b. Billiton, a dead explanate coral crust (with *Montipora exigua*). „ „

18. Montipora erosa.

Manopora erosa, Dana, Zoophytes (1848) p. 504, pl. 46, figs. 5, 5*a*.
Non *Montipora erosa*, Quelch, Chal. Rep., Reef Corals (1886) p. 178 (= *M. solida*).

Description.—Corallum encrusting, but rising and expanding from a small base into erect subangular branching stems which are "stout, acervately tuberculous, erose, obtuse," contracting and enlarging irregularly.

Calicles immersed, everywhere scattered, even at the summits. With a "flaring aperture," the "star being situated rather deep within." One cycle of septa.

The cœnenchyma is not spinulous, but uneven and porous.

The above somewhat obscure description is based upon Dana's text, and upon his figures of a specimen collected by the United States Exploring Expedition from Fiji. There are no specimens in the National Collection showing exactly the method of growth depicted. There is, however, a fragment which shows some approach to this method of growth, and may be provisionally placed here. The specimen had been provisionally labelled in Brüggemann's writing *M. Rus* Forskål. But the original description of this latter species lays such stress upon the presence of keels ("carinæ") and papillæ that it is difficult to believe that it could refer to a form like this specimen. This fragment bears some resemblance also to *M. spongodes* (see p. 37).

a. Locality not recorded. [Register No. 97. 6. 18. 4.]

19. Montipora solida. (Pl. IV. fig. 1.)

Montipora erosa, Quelch (non Dana), Chal. Rep., Reef Corals (1886) p. 178.

Description.—Corallum glomerate, swelling upwards from a comparatively small base into great rounded (pulvinate) nodules, the smooth surface of which may be thrown into irregularities owing to the presence of commensal Balanids.

Calicles small (0·50 to 0·75 mm.), rather scattered, from 1 to 2 mm. apart. No clear outline; the aperture is conspicuous because generally sunk beneath the level of the surface reticulum, through the irregular breaks in which the polyp must have protruded. The septa,

which are unsymmetrical, appear in parts of two cycles; the directives, which are sometimes prominent, may meet a short way down in the calyx; when an aperture lies below the level of the surface reticulum, one or two septa may appear at the edges of the bordering flakes or threads, showing that the calicles rise slowly in the thickening cœnenchyma.

The cœnenchyma in section consists almost entirely of long, thick, nodulated trabeculæ running continuously and very distinctly through the great thickness of the corallum. Under every tuberosity of the corallum, these trabeculæ radiate fan-shaped. They are joined by short stout junctions which do not run in horizontal floors. At the surface, there is no trace of this trabecular structure; a very stout reticulum with large open pores spreads evenly over the whole corallum, through the breaks in which the calicles appear. When the trabeculæ rise at all above the surface they appear to be merely parts of the smooth threads of the reticulum. There is no formation of surface tubercles.

This remarkable coral is represented by only one specimen which was originally labelled *M. crosa*, Dana, by Quelch. But the peculiar trabecular structure of the cœnenchyma in the specimen does not favour the idea that it could ever produce the corallum figured by Dana as *M. erosa*.

The specimen is about 7 cm. high, and shows a base of fracture about 5 by 9 cm. The texture throughout the whole mass is singularly uniform, and not unlike that shown in pulvinate specimens of *Astræopora* (see left side of fig. 1, Pl. IV.). The surface reticulum is so loose and open that individual meshes are often not much smaller than the calicles and only distinguishable from them to the naked eye by the deep fossa of the latter.

The specimen is peculiar in the fact that it is one of the very few truly glomerate forms known in the genus (cf. *M. verrucosa*). Massive Montiporæ are generally built up by repeated encrustations (e.g. *M. spongodes*). There is no other specimen showing such an immense thickness with continuous trabeculæ running right through the whole depth. Long trabeculæ occur in *M. cactus* and in *M. mammillata*, but in the latter there is evidence of periodical encrustations and not a continuous thickening; while in the massive forms of *M. verrucosa* the cœnenchyma is reticular throughout, without differentiation of its vertical elements into trabeculæ.

The upper surfaces of the single specimen have been badly injured, probably in attempting to break the mass away from its attachment, but the sides show the original character (see right centre of figure).

The surface of fracture is interesting because it has largely followed the trend of the trabeculæ which, rising upwards in the axis, bend outwards in all directions towards the surface.

Certain Balanids seem to have adapted themselves to this coral and its evidently rapid growth in thickness. Settling quite small on the surface they grow longer and longer, and leave long, smooth, calcareous, funnel-shaped shells running deep down into the corallum.

I originally classed this with the specimens of *M. mammillata* in which the trabeculæ rise into short tubercles above the surface. The complete absence of tubercles on this type lead to its resting place among the glabrous Montipores.

a. Mactan Island. H.M.S. 'Challenger.' (Type.)

20. **Montipora spongodes.** (Pl. III. figs. 2 and 3; Pl. XXXI. fig. 16.)

Description.—Corallum encrusting, creeping down round former growths, but also rising up into solid shapeless masses, jagged or even branched, the branches being smooth. The masses light, like pieces of pumice stone.

Calicles small, under 1 mm., evenly distributed, generally rather wide apart. Parts of two cycles of septa formed by free ends of the reticulum of the cœnenchyma. Septa always thinner than the threads composing the reticulum, those of the second cycle much finer than those of the first.

Cœnenchyma evenly reticular throughout, superficially resembling the texture of the bath sponge.

The above description applies to a group of specimens all showing the same general characters, but of many different shapes.

a. Providence Island, Mascarenes (coral bottom, 19 fathoms). H.M.S. 'Alert.' [82. 10. 17. 194.]

In this specimen (*a*) the coral has almost completely invested some irregular foreign body, perhaps a previous growth. On the one side it has grown out into a solid mass terminating in irregular branches which tend to rise, and on the other it has sent out a free expanding layer, with calicles on both sides, which, instead of rising, has drooped and seems to have touched the substratum at many points.

The calicles are small, but are visible as faint whitish rings just raised above the cœnenchyma or on the explanate portions as slight mounds, the apertures themselves being barely visible. They are not crowded, being some 2 mm. at most apart. The first cycle of septa nearly close the fossa; those of the second cycle, which appear in the larger calicles, are very fine.

The reticulum on the upper surface is rather close and flaky, the free ends forming short echinulæ; on the under surface it is more open and thread-like, and the echinulæ are long and conspicuous.

b. Original label detached, but probably from same locality as *a*. H.M.S. 'Alert.' [97. 6. 18. 5.]

The corallum in this specimen (*b*) is a thick shapeless mass, the upper surface of which runs out into irregular conical points. It appears to be largely hollow, and to have arisen by a thin growth hanging down more or less freely over a previous growth of the same coral, the under surface being followed by an epitheca and the lowest growing and pendent edge being about 3 mm. thick. This is the specimen figured on Pl. III. fig. 2.

The calicles are evenly distributed but much further apart than in *a*, and there is not the same tendency to rise above the surface. The two cycles of septa irregularly but more equally developed, i.e. there is not the same marked difference in development between the first and second cycles. A well developed, deep, cylindrical fossa renders them conspicuous

as pores of very different sizes, the largest about 1 mm., the smallest only faint specks. These latter are young calicles opening on the surface of the cœnenchyma; the large calicles are regularly circular or star-shaped. (See Pl. XXXI. fig. 16.)

The cœnenchyma is a light, wide-meshed reticulum, the threads of which tend here and there to be flaky.

c. Darros Island, Amirante Group, 22 fathoms, broken coral. — H.M.S. 'Alert.' 82. 10. 17. 124.

The corallum in this specimen (*c*), which is a thick irregular block, seems to be due, as in the last, to a thin layer having enveloped a previous growth, without, however, always being in close contact with it. Where the free edges are seen, at a few gaps in the under surface of the mass, the layer is about 3 mm. thick and followed by an epitheca. The whole stock seems to have been free. On the upper side the corallum is rapidly thickening by throwing up a number of branchlets of all sizes and shapes. The lower portion of the mass appears as if about to die down, when it would probably have again been grown over in its turn by coral from the upper living portion. (Pl. III. fig. 3.)

The calicles resemble those of the last specimen (*b*), but are not so regularly circular or star-shaped, and the septa are less regular. The calicles are very unevenly distributed, in one place less than 1 mm., in another, 3 to 4 mm. apart. The cœnenchyma is closely but delicately reticular; on the lower portions, the ends of the threads expand into flat, jagged or nodulated plates not unlike oak-leaves; these together give the surface a solid appearance and lead on to the formation of a film which creeps slowly up over the basal dying portions.

d. Marie Louise Island, Amirante Group, 17 fathoms, coral bottom. — H.M.S. 'Alert.' 82. 10. 17. 215.

Specimen *d* is a nodulated mass broken away from its base to which it had been attached by a narrow neck, and in many points resembling the specimen of *M. solida*.

The calicles are rather more conspicuous than in the foregoing, the apertures being apparently slightly sunk below the level of the cœnenchyma. They are of all sizes from 1 mm. to mere specks, and are about 2 mm. apart. The septa are very short solid projections round a wide and deep fossa; they are arranged irregularly in two cycles almost equally developed.

The cœnenchyma is very solid, the threads of which it is composed being thick and smooth; the free ends stand up as stout echinulæ. The specimen is somewhat heavier than the foregoing, which are as light as or even lighter than pumice stone.

e. Darros Island, Amirantes. — H.M.S. 'Alert.' 82. 10. 17. 190.

f. Marie Louise Island, Amirante Group, 17 fathoms, coral bottom (in four pieces). — H.M.S. 'Alert.' 82. 10. 17. 205.

Two branched specimens (*e*, *f*), the branches being cylindrical, with a slight tendency to flatten out fan-shaped at the tips. In specimen *f*, which was a large specimen, unfortunately broken, the basal piece is retained; it is found to be closely encrusting a prominence (branch ?)

of a former growth. One section is hollow and lined with epitheca—a fact which links the specimen closely with the foregoing.

The calicles are rather more conspicuous (as pits of all sizes under 1 mm.) than in specimens *a* to *c*. Probably on account of their branched form, the specimens are rather denser and thus heavier than the more massive forms.

g. Macclesfield Bank, China Seas, wide lagoon, sand. Coll. Bassett-Smith. 93. 9. 1. 75.

This is only a small fragment from quite a different locality, the method of growth of which deserves separate description. In all essentials it agrees with the foregoing specimens, i.e. in reticular character of the cœnenchyma and size of calicles. A horizontal expanse, 2 mm. thick, supported by an epitheca, rests across the tips of two pillars rising up perpendicularly 2·5 cm. in height from the level surface of a previous growth of the same. The process is closely similar to that exemplified by the specimen of *M. obtusata* (p. 33) from Fiji. The lower growth is covered with white film, but the tips of the pillars have grown out into fresh growth in several places. Indeed, it seems probable that the new stock is due to a table-like expansion of the top of one or more of these pillars.

21. **Montipora divaricata**. (Pl. III. fig. 4; Pl. XXXI. fig. 17.)

Montipora divaricata, Brüggemann, Phil. Trans., clxviii. (1879) p. 577.

Description.—Corallum an irregular nodulated mass, built up of successive layers of coral, each layer rising up at the free edges and on the summits of prominences into fresh tufts of branching lobes. The ultimate branchlets are irregular in shape and distribution, and average about 1 cm. in diameter and about the same in length.

Calicles are conspicuous and numerous, slightly under 1 mm. in diameter and about the same distance apart.* On the upper faces of the stock, the apertures are not very sharply defined but are slightly sunk in the reticulum of the cœnenchyma. On the lower faces, they are sharply defined and open flush with the level interstices. Two cycles of short, stout septa, the secondaries being slightly shorter than the primaries. Fossa deep and open.

Cœnenchyma, a rather dense nodulated reticulum, open and slightly surging up in the interstices on the upper surfaces of the stock, but more solid and smooth on the lower surfaces. The axial streaming layer in sections of branches not sharply marked off from the cortical layer.

There is only one specimen of this coral, viz. Brüggemann's original type. In describing it, it was said to be allied to *M. rus* and *M. monasteriata*, but to differ from these in "mode of

* Brüggemann says the calicles are 2 mm. apart. It is true that round the bases of the tufts and on the lower sides of slanting tufts, where the cœnenchyma is becoming denser and consequently narrowing the calicle apertures, the latter are further apart; but on the upper faces of the mass they are as often as not less than 1 diameter distant from one another.

growth and absence of the prominent verrucæ." According to the method of classification here adopted these latter are tuberculate Montiporans, and therefore almost the most specialised, whereas the present type belongs to the most primitive group.

The branching is not true branching but more the running out of free points at any part of the stock into irregular sloping and tufted clumps. There are traces of at least three successive growths; the dead masses of former stocks can be seen to have had the same methods of growth.

In general character of the calicles this type is not far removed from *M. spumosa* (see p. 71). It is doubtful whether this ought not to be placed in the next division (glabro-foveolate) on account of the slight surging up of the interstices. Its smooth appearance (see Pl. III.) led to its being placed among the glabrous specimens.

a. Rodriguez. Royal Society. 76. 5. 5. 75. (Type.)

22. **Montipora mollis.** (Pl. III. fig. 1; Pl. XXXI. fig. 18.)

Description.— Corallum either an encrusting layer 1 cm. thick, surface rising into irregular rounded nodules and humps, or towering up and expanding into irregular branching and nodulated pillars fusing with one another irregularly.

Calicles crowded, less than their diameter apart, varying greatly in size, under 1 mm., delicately star-shaped, and sunk in shallow depressions in the apparently woolly surface of the cœnenchyma. Six well developed septa, one of which is generally prominent, exsert, and thick, reaching right to the centre of the calicle, hence there is no distinct fossa. The interseptal loculi only loosely and irregularly bounded peripherally by the cœnenchyma, points of which may project irregularly into the calicle aperture as the rudiments of the second cycle of septa.

The cœnenchyma in section shows a rather dense laminate reticulum, low down in encrusting portions, or occupying the axis of the branches in the towering portions. Upon or around this is the thickening layer, the vertical elements of which appear as thin, flat, saw-like trabeculæ with teeth on both sides. On the surface, the tips of the trabeculæ end as jagged flakes or granules twisted in all directions, free or fusing, terminating at the same level. At the tips of rising nodules or branches, the laminate reticulum, coming to the surface, forms irregular line patterns, the edges of the laminæ being all on the same level. The interstices tend to swell slightly above the level of the calicle apertures.

There are two specimens which I have classed together under this head. They are united by the general woolly aspect of the cœnenchyma and by the characters of the calicles.

The one (*a*) is an encrusting form some 7 cm. square, while the other (*b*) is a confused mass of irregular nodulated branches broken off from some unknown base. The mass had been attached at two points, the larger of which is less than 2 cm. in diameter. The tips of the tallest branches of this latter specimen appear as if they had been mechanically hindered

from growing any higher, they tend to expand into smooth, slightly rounded plateaux on which calicles endeavour, with no great success, to open.

a. (Encrusting specimen) Palm Island, Great Barrier Reef. Coll. Saville-Kent. 92. 12. 1. 4
b. (Towering specimen) Warrior Island, Great Barrier Reef. „ „ 92. 12. 1. 257
} (Types.)

[On an apparently allied species, *M. pilosa*, see Appendix.]

c. Ramose.

23. **Montipora levis.** (Pl. XXXI. fig. 19.)

Montipora levis, Quelch, Chal. Rep., Reef Corals (1886) p. 172, pl. viii. figs. 2, 2*a*.

Description.—Corallum forms short tufts, the individual stems of which tend immediately to flatten so as to form cockscomb-like expansions, the edges of which send off short, pointed branchlets. The basal portions of the stock die down, the living zone being about 6 cm. deep.

Calicles minute and inconspicuous, from 0·25 to 0·5 mm. and about 1 mm. apart. Primaries well developed, prominent, reaching to or beyond the half radius circle, one (or two) being pronounced as directives. A second cycle just indicated. These prominent septa obscure the deep fossa.

Cœnenchyma shows an open reticular axial strand (which becomes nearly solid in the basal portions of the stock); this is surrounded by a much denser radial reticulum. The interstices appear almost solid, but covered with small ridges like granules which closely resemble in general aspect the white edges of the septa with which they are often connected. Here and there in the upper portions of the stocks, the surface is slightly pitted owing to the irregular upsurging of the interstices.

This type appears to be distinct. Quelch considered it to be near *M. digitata*, Dana, and attributed to it five specimens, one of which was described as a variety. Close inspection shows that this variety is in reality a specimen of *M. palmata*, Dana, obscured by being unusually smooth. The calicles, however, are the same as in that type, and on the older parts of the stock tend to develop thin ridges marking off the flat, polygonal areas in the centre of which the calicles open, which are characteristic of *M. palmata* (see p. 66).

Indeed, the relationship of this type with *M. palmata* appears to me to be much closer than it is with *M. digitata*.

a. Banda. H.M.S. 'Challenger.' [86. 12. 9. 256.] (Type.)
b. (Broken from *a*.)
c, d. (Small stocks), Fiji Reefs. H.M.S. 'Challenger.'

24. **Montipora compressa.** (Pl. III. fig. 5; Pl. XXXI. fig. 20.)

Millepora compressa, Esper (non Linnæus), Pflanzenthiere, i. (1791) p. 203, taf. x.
Manopora compressa, Dana, Zooph. (1848) p. 494.
Montipora compressa, Milne-Edwards and Haime, Ann. d. Sci. Nat., (3°) xvi. (1851) p. 63.
Montipora rigida, Quelch (*non* Verrill), Chall. Rep., Reef Corals (1886) p. 173.

Description.—Corallum a loose, bush-like cluster of long and very irregular branches, often broadened and flattened, fragments often resembling young reindeer horns, with the branchlets short and thick. The thinner cylindrical portions of the main branches are about 1 cm. thick. Branches fuse freely. Height at least 16 cm.

Calicles conspicuous, neatly circular, about 0·75 mm. in diameter, averaging about 1 mm. apart, each calicle lined by a membranous layer of cœnenchyma which rises slightly above the surface as a thin white ring. On the young branchlets and growing tips, the proximal edges of this membranous wall stand out so that the calicle looks slightly upwards; elsewhere the ring lies parallel with the interstice. Septa, as a rule, very irregular and feeble at the margin, but become more prominent deep down in the fossa. Occasionally the white ring is regularly and evenly bent so as to follow the outlines of six equal, short, petaloid, interseptal loculi (cf. Esper's fig. 3 and Pl. XXXI. fig. 20, left lower corner).

Cœnenchyma shows in section a thick, strong, laminate streaming layer, sharply marked off from a radial layer which is often so dense as to appear solid, with the exception of the irregular canals and pores running through it. The basal fragments are much heavier than the younger fragments from the upper portions of the stock. The interstices are covered by conspicuous white lines and granules, often grouped to form a flat network joining the white rings round the calicles. This network is, however, seldom so conspicuous as are the calicular margins.

There are ten fragments of this coral which can be fitted together to form two specimens, one of which (*a*) is a large and imposing stock, 16 cm. in height (figured on Pl. III. fig. 5). This species is distinguished from the next chiefly by the greater coarseness of the surface texture and the larger size of its calicles.

Quelch's identification of this with Verrill's *M. rigida* cannot stand, as there is no trace of the foveolation which appears to be the special characteristic of Verrill's type. On the other hand, the peculiar and slightly prominent white membranous rings lining the apertures of the calicles ally it unmistakably with the *M. compressa* figured by Esper. This author had identified his specimens, which were from some unknown locality, with the *Millepora compressa* of Linnæus,* said to be from the Mediterranean, a locality which practically excludes the possibility of this identification. Dana first recognised that Esper's type was a true Manopore (Montipore).

In addition to the peculiarity which characterises the type, it is worth noting that the

* Syst. Nat., ed. xii. (1766) p. 1283.

branches seem to die away in any part, not necessarily at the base, and are then coated over again by a thin layer of living coral.

This coral is said (on Quelch's original labels) to be "the most abundant reef-forming species on the island of Mactan, Zebu."

a. Mactan Island. H.M.S. 'Challenger.' [86. 12. 9. 255.]
b. Mactan Island. H.M.S. 'Challenger.' [86. 12. 9. 357.]
c. (A fragment fitting on to *a*.)

25. **Montipora alcicornis.** (Pl. XXXII. fig. 10.)

Description.—Corallum grows out into thin crooked stems which widen into irregular elks' horn-shaped expansions 4 to 5 cm. across. From these expansions, one of the usually short blunt prongs runs out and again widens.

Calicles very numerous, varying in size from 0·5 mm. and under, like pinholes in the smooth surface. Septa as six thin, sharp, and toothed ridges projecting but a very little way into the fossa. The margin of the calicle is generally sharply defined by a continuous neatly petaloid rim.

Cœnenchyma consists of a laminate reticulum which streams along the axes of the branches. The transition between this and the cortical layer is gradual, the latter layer being also decidedly flaky, the pores being in many cases neatly round or oval. Except at the growing tips and on the upper surfaces of the sloping branches, the cœnenchyma is smooth, but is lined all over in an irregular pattern by the thickened white upper edges of the bands of the reticulum. On the upper surfaces above mentioned, the thin walls forming the petaloid rims rise slightly so that a narrow irregular jagged furrow runs between the calicles.

The single specimen formed an extensive tangle of dead and living branches which grew at a small angle with the horizon, being depressed by the large flat growth of *M. calcarea*. Wherever the edge of this latter coral rests upon the "elks' horns" of its branching congener its cœnenchyma foams up in a wonderfully rich manner (see Pl. X. on the left, also p. 59); perhaps the support relieved it of the necessity of thickening and strengthening its substance for free horizontal growth.

This coral differs from the last type in the much smaller average size and comparative inconspicuousness of the calicles, and in the much finer texture of the surface cœnenchyma. A comparison of the descriptions will show how near the two approach in essential features, and it may be that the differences are due to the unfavourable position in which the specimen here described has grown.

It differs also from the specimens of *M. gaimardi*, which are from the same locality, and are also ramose, in the total absence of the six slightly projecting conspicuous septa, in the characters of the surface cœnenchyma, and in the method of growth.

The peculiar white chalkiness which characterises *M. calcarea*, though slightly less marked, is seen here also, although it is not in the Tonga specimens of *M. gaimardi*. This variation is probably due to some purely local conditions of the environment.*

* On the suggestion that these are corroded specimens, see on *M. calcarea*, p. 60, and *M. hirsuta*, p. 165.

The tendency of the septa to be lamellate is an interesting feature in this type (see Introduction, p. 13).

a. Tongatabu (with *M. calcarea*). J. J. Lister, Esq. [91. 3. 6. 28.] (Type.)
b. (A detached fragment of *a*.)

26. **Montipora fruticosa**. (Pl. IV. fig. 2; Pl. XXXII. fig. 2.)

Description.—Corallum forms small close tufts of thin branches, averaging 4 to 5 mm. thick, excepting in some cases when the main stems thicken irregularly to 10 mm. Tufts irregular in shape, round and bushy, or palmate, with main stem flattened and with ultimate branches slightly compressed and widened at the tips. The living zone is about 6 cm. deep.

Calicles as deep round holes, as if punctured in the almost solid corallum, very conspicuous, minute, 0·35 mm. in diameter, evenly distributed, about 1 mm. apart. As a rule with only the faintest traces of septa as six slight projections.

Cœnenchyma consists of a laminate axial reticulum, well developed and forming the apices of the young branches, where it is very friable, the laminæ being delicate and thin. Lower down, an almost solid cortical layer appears, while the bands of the axial reticulum become much thicker. Old stems are nearly solid, although the original differentiation into axial and cortical layers can be seen. The gradual change from the reticulum which comes to the surface on the sides of the young branches to the solid cortical layer can be traced. The solid layer is frosted over with minute granules.

There are seven specimens representing this type. Three of them are round bushy tufts, the thin cylindrical branches fusing with one another; while the remaining four rise up as thickened, slightly flattened stems, the whole clump tending to be compressed and even palmate. The tips of the young branches may also in these cases be compressed.

The two divisions, are, however, not very distinct; the whole number forms a continuous series. They are, moreover, unmistakably linked together by the calicles, which are like punctured holes. These apertures are so marked a feature that I have no hesitation in separating this from the *M. digitata* of Dana in which the apertures are irregular breaks in a surface reticulum (cf. Zooph., pl. xlviii. fig. 1*c*).

a. Warrior Island, Great Barrier Reef. Coll. Saville-Kent. 92. 12. 1. 328. (Type.)
b. Great Barrier Reef. „ „ 92. 12. 1. 526.

(*a* and *b* are bushy specimens, cf. Pl. IV. fig. 2.)

c, *d*, *e*. Great Barrier Reef. Coll. Saville-Kent. 97. 6. 18. 9. 10. 11.

(*d* and *e* with flattened tips to the branches.)

f. Great Barrier Reef Coll. Saville-Kent. 92. 12. 1. 527.
g. „ „ „ 92. 12. 1. 550.

(*f* and *g* are irregularly ramose expansions of tall straight stems.)

27. Montipora spicata.

Description.—Corallum a small stunted tuft rising on a stem which branches irregularly; the branches flatten, the young branches are short tapering spikes about 1 cm. long, springing almost anywhere and with calicles right up to their tips. The stem, which is under 1 cm. in diameter, dies away, the living colony being 5 to 6 cm. deep from the tips of the branches to the edge of the dying surface. As growth proceeds the small pointed branchlets thicken, their tops flatten, and then apparently again throw up small processes.

Calicles are conspicuous, small, 0·5 mm. diameter and very evenly distributed about 1 mm. apart. The calicles appear regular, star-like, with one well developed cycle of septa and parts of a second; the directives are well marked, the upper one being often exsert; the calicles tend to be arranged in longitudinal series.

The cœnenchyma is very porous and spongy, consisting of stout threads. The axial streaming layer is well developed, and passes imperceptibly into the cortical layer, which is also reticular, only in this latter layer the threads are radially arranged and run out into short irregular echinulations which, seen from above, are mere granulations. Except for these the surface is a smooth porous reticulum, composed of flat flakes with large perforations. The interstices are perfectly level.

This description applies to a single specimen without any label, which I have found impossible to associate with any of the other smooth ramose Montipores. The rough, granular, somewhat flaky reticulum which forms the surface, somewhat resembles that of *M. ramosa*, but is altogether on a much smaller scale. In general appearance and size the specimen approaches *M. fruticosa*, but its calicles are quite different, and its surface is porous and not solid except very low down on the stem. Here the visible septa are merely irregular surface granules projecting over the edge of the aperture. The margin of each calicle is stained a deep yellow.

The short pointed branchlets, after which the specimen is named, remind one of the similar processes in *M. levis*. But this latter coral differs widely both in the calicles and in the texture of the cœnenchyma.

a. Locality not recorded. [Register No. 97. 6. 1. 12.] (Type.)

28. Montipora rubra. (Pl. XXXII. fig. 9 as *M. forbesi*.)

Alveopora rubra, Quoy and Gaimard, Voy. de l'Astrolabe, iv. (1834) p. 242, pl. xix. figs. 11–14.
Alveopora rubra, Dana, Zoophytes (1848) p. 512.
Montipora rubra, Milne-Edwards and Haime, Ann. Sci. Nat., (3°) xvi. (1851) p. 62.
Non *Montipora rubra*, Quelch, Chall. Rep., Reef Corals (1886) p. 172.

Description.—Corallum small, ramose, dichotomously branching, 6 to 7 cm. high; branches cylindrical, 5 mm. thick near the tapering but rounded tips, 7 to 8 mm. thick nearer the main stems. Branches meeting and fusing.

Calicles minute but distinct, 0·5 mm. diameter, opening on the young branches as mere irregular breaks in the reticulum, but lower down through thick cœnenchymatous rings which are not protuberant and often asymmetrical. Six thin and feebly developed septa with faint incomplete traces of a second cycle. Septa are pointed, directives often exsert plates.

Cœnenchyma consists of a stout open reticulum; the axial layer is only distinguished from the cortical layer by the disposition of its elements and not by any difference of density. The stout reticulum makes the surface rough.

The type specimen of this coral is a fragment in the Paris Museum; its most striking feature is the peculiar circumscribing of the calicles by a stout ring of cœnenchyma. The specimen in our National Collection which comes nearest to it is a somewhat larger fragment which differs from it, as far as I can see, only in the fact that the reticulum is somewhat lighter. The rings round the calicles, the dichotomous branching, and the general size are alike. I had already named this specimen *M. forbesi*, but after comparing it with the original of *M. rubra*, I believe the two are specifically identical.

From the original description we learn that the twelve tentacles of the polyps are well developed for this genus, being swollen and fusiform, but with rounded tips. The whole stock is a bright red-brown colour.

Our specimen shows a slight difference in the surface texture on the two sides (cf. the specimens of *M. Gaimardi*): the one side shows the rough reticulum, the other is composed of smooth, thick, serpentine threads (Pl. XXXII. fig. 9).

a. Keeling Island. H. O. Forbes, Esq. [84. 2. 16. 2.]

29. **Montipora superficialis.**

Montipora superficialis, Brüggemann (manuscript name).

Description.—Corallum ramose, stem cylindrical, 8 mm. thick, young branches short, round and thick.

Calicles small, 0·75 mm., conspicuous, crowded but evenly distributed, rather less than one diameter apart. Margin of aperture not defined at surface, hence they appear to the naked eye very irregular in shape. The six primaries distinct and exsert, but not projecting above the highest level of the interstices; the directives are slightly larger. These exsert septa are mostly smooth, white, conspicuous laminæ in striking contrast to the irregular echinulæ of the surface reticulum. The primaries reach to about the half radius circle.

Cœnenchyma. The axial streaming layer is a coarse, rather close reticulum which changes gradually into the radial cortical layer which is also a coarse, rather solid reticulum. On the more pointed branchlets the axial strand forms the growing tip without calicles; on the more rounded tips, young calicles appear, but these have not the characteristic septal apparatus; this only appears on the older calicles opening in the cortical layer.

The single specimen was named *M. superficialis* by Brüggemann in his MS. catalogue, and referred to under this name on p. 208 of vol. v. of the Jour. Mus. Godef., 1879. It appears, however, never to have been described by him. The specimen was labelled with the

words "type species" inscribed on the label. It is only a fragment, being the tip of a stem ending in three short branchlets, the whole being only 3 cm. long. The exsert laminate septa are peculiar and would alone serve as a specific distinction. A very similar character is found in some examples of *M. gaimardi*, but the calicles there are much smaller and the peripheral (costal) edges of the septa are not so free and laminate, but are frequently thickened with a kind of T-piece, which indicates the advancing wall of the fossa, using the term "wall" in a limited sense for the innermost ring of tangential interseptal plates.

a. New Zealand. Coll. Stokes. [97. 6. 18. 13.] (Type.)

30. **Montipora nana.**

Description.—Corallum stunted ramose, with thick, short, round stem, giving off short, round thick branches, the latter hardly tapering, with blunt, rounded ends. Stem about 1 cm., and branches 6 to 7 mm. thick.

Calicles somewhat conspicuous, 0·75 mm. in diameter and from 0·5 to 0·75 mm. apart. Apertures neatly marked out by clear, continuous or slightly interrupted membranous rings, not rising above the surface, but often separated from one another by a deep, irregular furrow; the rim is thin, only very slightly petaloid, often quite circular. The primaries irregularly developed, inconspicuous as thin rods, only complete in the depth of the fossa. Directives may be laminate but only deep in the fossa; minute point-like secondaries also appear irregularly.

A loose, open, and very friable laminate reticulum forms the rounded tips of the branches. The transition from the axial to the radial cortical layer appears to be somewhat sudden. The radial threads in the thickening stem and proximal portions of the branches run out into sharp echinulæ which give a soft woolly appearance to the surface.

There are two specimens of this coral, which appears to be distinct from all the smooth ramose types yet described. The larger specimen rises about 6 cm. high from the tip of a decayed corallum of the same species. The smaller specimen, which was probably collected at the same time, is only 3 cm. high, and has also been broken from a dead previous growth.

In its calicles with continuous rims it approaches *M. rubra*, *M. compressa*, and *M. alcicornis*, but the character of the rim is very distinct from that of any of these types.

a. Port Molle, Queensland (5 fathoms, coral bottom). H.M.S. 'Alert.' 82. 2. 23. 158. (Type.)

b. North-east Coast, Australia. H.M.S. 'Alert.' 82. 2. 23. 139.

31. **Montipora digitata.**

Montipora digitata, Dana, Zoophytes (1848) p. 508, pl. xlviii. figs. 1, 1*a*, 1*b*, 1*c*.
Montipora digitata, Milne-Edwards and Haime, Ann. d. Sci. Nat., (3°) xvi. (1851) p. 66.

Description.—Corallum small, branched, often digitate, branches subterete, slightly compressed, often tortuous, 6 mm. thick, subequal, obtuse.

Calicles crowded, immersed, 0·3 mm. in diameter.

Cœnenchyma perfectly smooth.

This is Dana's description of a small branched Montipore from the Fiji Islands. It was 8 to 9 cm. long, with numerous crowded branches 7·5 cm. long. The polyps were yellow, with short tentacles. Near the tips the branches were slightly pitted, the depressions being 2 mm. across.

There are three specimens labelled *M. digitata* in the National Collection. One is now classed under *M. rubra* (see above). The two remaining specimens, which are only fragments, are, I think, rightly identified. At first sight they are very unlike one another. One (*a*) is almost smooth, with each calicle surrounded by a very solid, faintly protuberant ring, while the other (*b*) has the calicles sunk in slight swellings of the reticulum and moreover not sharply surrounded by any solid ring. Careful examination, however, shows that these two are related. The cross sections are very similar, the form and size of the apertures are alike, and here and there, small patches on each show the peculiar specialisation of the other.

We may, therefore, add to Dana's description the following. The slight pitting (foveolation) of the surface of the branches may be continued down the stem, or may be replaced by a very different solid ring surrounding the aperture. There are six short, thick, symmetrical septa, leaving a deep, somewhat open fossa; the interseptal loculi are usually sharply defined. In cross section, the laminate axial reticulum is very open but strong, and in marked contrast to the dense white cortical layer, the structure of which out of radiating thickening threads can be easily seen. The transition from the axial to the cortical layer is quite sudden. The axial layer forms the tips of the branches, and it is to be noted that neat star-like calicles crowd it to the very tip.

The demonstrable specific identity of these two specimens, in spite of such striking dissimilarity in their surface texture, shakes one's confidence in the validity of some of the foregoing species. Portions of specimen *a* are hardly distinguished from the type specimen of *M. rubra*. The sections of the stem in the two cases are, however, in marked contrast. Until we have the definite evidence supplied by longer series of specimens there is no alternative but to describe each striking variation as a new species.

a, *b*. Shortland Island, Solomon Islands. Dr. Guppy. 84. 12. 11. 31.

32. **Montipora tortuosa.**

Manopora tortuosa, Dana, Zoophytes (1848) p. 509, pl. xlviii. fig. 2.
Montipora tortuosa, Milne-Edwards and Haime, Ann. d. Sci. Nat., (3°) xvi. (1851) p. 66.

Description.—Corallum ramose, with long branches (10 cm.), thin (6 mm.), bent or tortuous, subcylindrical, slightly compressed.

Calicles immersed, somewhat scattered, 0·5 mm. across. Cœnenchyma perfectly smooth.

Dana adds that this type (from Singapore) is very like the last, but that the branches are longer and the calicles larger. From the drawing also, the calicles are much more scattered than they are in *M. digitata*. There is no enlarged figure given of the cœnenchyma.

There is no certain representative of this coral in the National Collection. See, however, the thin tortuous specimens of *M. ramosa*; also the thin tortuous branches of a Montipore entangled in and partly encrusted by specimen *a* of *M. foliosa*.

Group II.—GLABRO-FOVEOLATE.

33. Montipora ramosa. (Pl. V. figs. 1, 2, 3; Pl. XXXII. fig. 3.)

Description.—Corallum a tuft of cylindrical but irregularly bent and swollen stems, either all short, thick, massive, and nodulated, or tall, slender, and tapering. The tips of the branches often expand and give off irregular clusters of short tapering lobes, which rise into branchlets, either more or less fused together or diverging. The size of the cluster depends upon the thickness of the branch. The lower portions of the stems die down, the living coral being about 12 cm. deep.

Calicles small, conspicuous, crowded, about 1 diameter apart, 0·75 mm., with very irregular margins. Primaries symmetrical, reaching to about the half radius circle, thin, composed of such straight series of spines as to suggest their being laminate; two directives conspicuous, often laminate. No developed secondaries.

Cœnenchyma very densely reticulate, the axial streaming layer early obscured by the thickening of its elements. It appears, however, less dense at the tips of the more finely tapering processes, which are often without any calicles. Thicker and more rounded excrescences with greater diameter than the axial strand are always covered with calicles. The peripheral reticulum of the thicker stems is also very dense, its radial elements being thickened like irregularly nodulated trabeculæ. In the higher portions, on the tapering points and rounded knobs, the reticulum rises up in the interstices to form the typical foveolate ridges. The ridges are rounded swellings of a rather close granular reticulum. In the lower and older portions of the stems these flatten out, and the surface is almost smooth, the reticulum becoming more dense, and the calicular apertures smaller and hence further apart. The granules on the surface are the ends of the reticular threads (see Pl. XXXII. fig. 3).

There are five specimens of this coral, representing two complete stocks, and three fragments of a third. The methods of growth of the three are at first sight very different.

The largest specimen (*a*, Pl. V. fig. 1) has a thick nodulated stem. The clusters of thin processes from the tips of the branches fuse together. Divergence of these thin processes might at any time give rise to a thin-stemmed stock in the next period of growth. On the other hand, it is more probable that the method of growth, once started, perhaps by some accident, is persisted in throughout. For instance, there is on the dead portion of this specimen a small, thick, cushion-shaped mass about 1·5 cm. in diameter, resting on an epitheca. This looks like a young colony, and having a broad base to rest on appears as if it might grow up into a massive stock. On the other hand, a young colony on specimen *e*, which is a corroded portion of a thin-stemmed stock, having only a narrow base, viz. one of the thin stems, to rest on, begins at once to throw up a thin stock.

It seems very probable, then, that the character of the stock depends largely upon the accidental conditions in which each young colony starts growing.

Specimen *b* (Pl. V. fig. 3) is a thin-stemmed specimen, with the tips also tending to form clusters of thin tapering processes, fusing irregularly together. The whole stock is compact, squat, and laterally expanded.

The third specimen *c* (Pl. V. fig. 2) is composed of tall, thin, curved stems, recalling Dana's type *tortuosa*. The locality of this specimen is unfortunately not recorded.

I have figured these three specimens to illustrate the degree of possible variation of growth-form in one and the same species.

a. Ramesvaram, Gulf of Manaar.	E. Thurston, Esq.	88. 11. 25. 5.	(Type.)
b. Ramesvaram, Gulf of Manaar.	„	88. 11. 25. 4.	
c, *d*, *e*. Locality not recorded.	Register Nos. 97. 6. 18.	14. 15. 16.	

34. **Montipora rotunda.** (Pl. IV. fig. 4; Pl. XXXII. fig. 4.)

Description.—Corallum a massive round-oval stem, 4 by 3 cm. thick, the top swollen up and irregularly knobbed and lobed.

Calicles conspicuous, very uniformly distributed about 1 diameter apart, 0·75 to 1·0 mm., slightly sunk, very irregular apertures, six irregular septa.

Cœnenchyma consists of an almost solid axial portion, surrounded by dense reticulum in which concentric solid rings can be recognised; these perhaps mark off the successive growths. In the outermost layer of the reticulum, radial elements are distinct; these appear to be confined to the coloured (orange-yellow) zone, which is 3·5 mm. thick. The slight formation of a solid layer along the inner edge of the coloured zone suggests that this was the limit of the living coral. On the surface, the cœnenchyma shows as an open network remarkable for its very angular, sometimes rectangular meshes, the threads of which it is composed being short and straight, but bent sharply at all angles with one another. This reticulum necessarily makes the outlines of the calicles very irregular. All the interstices seem to be slightly swollen up convexly.

It is difficult to decide whether this specimen should be classed with the foveolate or with the glabro-foveolate group. There is a swelling of the interstices, but it is not very prominent. It is best seen on the uppermost growing surfaces of the knobs or lobes.

The peculiar angular reticulum gives a unique and coarse look to this Montipore, which is also remarkable because of its continuous growth in thickness. It is thus at the same time both massive and branched.

a. Palm Island, Great Barrier Reef. Coll. Saville-Kent. [92. 12. 1. 9.] (Type.)

35. **Montipora spatula.** (Pl. IV. fig. 3; Pl. XXXII. fig. 8.)

Description.—Corallum is a tuft of broad, flat, erect branches, irregularly fused, rising at least 15 cm., dying down below, the living zone being about 7 cm. deep. Each branch tends to

suddenly flatten out like a spade for about 2 cm. from the top, the edge of which may be sharp and ridged. Similar flat vertical outgrowths may spring from the faces of these spade-like expansions.

Calicles evenly distributed about 1 diameter apart, 0·75 mm. Six primaries feebly and irregularly developed round the margin, not reaching the half radius circle; secondaries only here and there indicated. Fossa in full-grown calicles very shallow and open, the base being nearly level or filled up by a wheel-like arrangement of short septa with a large central but very irregular columella. Where the cœnenchyma is rapidly growing near the tips of the branches the fossa is deep and conspicuous, and the calicles may be merely circular membranous pits without septa round their apertures.

Cœnenchyma. The axial streaming reticulum is laminate, the edges of the laminæ forming an even line pattern along the topmost crests and ridges of the branches. The cortical layer is a stout open reticulum with only here and there slight traces of radial arrangement of its component elements. This reticulum rises up in the interstitial spaces to form a uniform system of ridges, as if the surface was slightly honeycombed. These ridges are sharpest and tallest near the tips of the branches; here the thin edges of the interstitial ridges slope slightly upwards. In the lower portion of the coral the ridges are mere convex swellings of the interstices, and these gradually flatten before the corallum dies down.

There is only one specimen which I have succeeded in reconstructing from three fragments which were recognised as belonging to one another. One of the fragments had been bleached, the others retained their original yellowish-brown colour (see Pl. IV. fig. 3).

The columella is only faintly indicated in the figure (Pl. XXXII. fig. 8). In some parts it is quite a conspicuous feature even to the naked eye.

a. Warrior Reef. Coll. Saville-Kent. 92. 12. 1. $\left.\begin{matrix}366\\277\end{matrix}\right\}$ (Types.)

36. Montipora marenzelleri.

Description.—Corallum small, branching, with smooth cylindrical stems from 6 to 7 mm. in diameter. The branches form wide angles with the stem, and shoot straight out for about 1·5 cm. before dividing into new branches.

Calicles are very conspicuous as deep round holes in the stem from 0·5 to 0·75 mm. in diameter, irregularly crowded, arranged not infrequently in close longitudinal series; transversely they may be nearly 1 mm. apart. Septal apparatus almost entirely obsolete, a few minute points appearing in the younger calicles.

Cœnenchyma shows a very delicate open band reticulum in the axes of the branches and forming their friable tips; this axial reticulum passes suddenly into a compact system of radially arranged threads of irregular thickness and largely fused together to form a dense cortical layer. When this is fully developed the stem is smooth, except for the minute granular tips of the radiating threads. On the younger branches, before this cortical layer is

developed and while it is being developed, the interstices rise up into ridges between the calicles, giving the surfaces of these parts a very pitted appearance; this, however, passes away as the stem thickens.

This coral from the Solomon Islands resembles *M. fruticosa* in the aspect of the calicles, looking, with their aborted septa, as clear round punctures in the smooth solid stem; but it differs from it in the size of the calicles and in the foveolate character of the surfaces of the branches. In this latter respect it comes near *Montipora gaimardi*, where the foveolation may be very pronounced; but in the almost complete absence of septa it differs greatly from this type in which the primary septa are very highly developed and conspicuous. It is also altogether more delicate and smaller than *M. gaimardi*.

In these points also it differs from Dr. Guppy's specimens of *M. digitata* from Shortland Island, Solomon Islands, although it somewhat resembles them in the character of the cœnenchyma in cross section.

a. Solomon Islands. Vienna Museum. [97. 6. 18. 17.] (Type.)

Group III.—FOVEOLATE.

a. Encrusting and Rising into Lobes.

37. Montipora libera. (Pl. VI. fig. 3; Pl. XXXII. fig. 6.)

Description.—Corallum consists of a flat unattached mass of rounded nodules, the whole built up by successive incrustations of a thin layer of coral, from 2 to 3 mm. thick. Each incrustation grows round and under the mass, the whole gradually losing its rounded symmetry by enclosing foreign objects which have become attached to the stock.

Calicles crowded and conspicuous, but sunk beneath interstitial ramparts, from 1 mm. in diameter on the smooth rounded upper surfaces of the nodules to minute specks crowded together in the shallow valleys between the same. The aperture is generally a well marked membranous ring, with twelve short and nearly equal septa, or else with two distinct cycles, the primaries being twice as long as the secondaries. Of the two directives, one may be strikingly exsert, rising almost as high as the interstitial rampart. The directives are frequently continuous laminæ.

Cœnenchyma consists of a light echinulate reticulum, which rises in narrow ridges forming angular ramparts round the calicles; young calicles often open at the angles where the ridges meet. The ramparts are in marked contrast to the membranous rings sunk down in their bases and which outline the calicle aperture. When these membranous rings rise up in the bases of the ramparts the calicles appear to have double walls.

There is only one specimen of this coral. It appears to have started by encrusting some small free object. Examination of the corroded parts of the under surface only shows successive layers of the same coral. On all these dead and corroded surfaces the foveolation comes out very strikingly. The small groups of foreign objects, worm-tubes, gastropod shells, orbitolites (some of the last being 1 cm. in diameter) make the mass irregular, but do not quite destroy the tendency to form smooth rounded nodules, except when the coral grows up round a small worm-tube. A well developed epitheca creeps along the closely encrusting edges, which grow round for some distance under the apparently detached mass.

The specimen is so markedly foveolate that there is no doubt as to its position. The appearance of double walls and the exsert directives, together with the method of growth, make it necessary to classify it as a new species.

a. Torres Straits. Prof. A. C. Haddon. (Type.)

38. **Montipora turgescens.** (Pl. VI. fig. 2; Pl. XXXII. fig. 11.)

Description.—Corallum explanate or encrusting, with free edges 3 mm. thick, supported by epitheca.

Calicles crowded, 1 diameter apart, sunk, 0·5 mm. across. Two cycles of nearly equal, short septa, irregularly developed round the aperture; the primaries are slightly larger than the secondaries; a large open fossa which makes the calicles, though small, very conspicuous.

Cœnenchyma shows a solid layer of varying thickness resting upon the epitheca, a coarse outwardly streaming layer which bends upwards to form a very compact layer; this appears as if composed of nodulated and somewhat irregular trabeculæ. The interstitial spaces are all evenly convexly swollen up; while on the level portions of the coral, median ridges appear half-way between the calicles. The edges of the ridges are sometimes marked by thin straight cœnenchymatous threads. On eminences, the interstitial spaces are swollen up so as almost to close the apertures of the calicles, which may then rise to the surface, the echinulæ of the cœnenchymatous reticulum forming the septal spines.

The six specimens arranged under this type illustrate very well the regular and even rise of the interstitial spaces, above the level of the polyp cavities. They might almost be classed as varieties of *M. foveolata*, in which the character reaches its extreme development. The specimens differ greatly in details not always easy to specify. The first four, which obviously belong to one another, vary much among themselves. They are deeply suffused with a rose-pink colour, and the calicles vary greatly in size; the height and development of the ramparts also vary greatly.

a. Green Island, Great Barrier Reef.	Coll. Saville-Kent.	92. 12. 1. 2.	(Types.)
b. Capricorn Island, Great Barrier Reef.	„	92. 12. 1. 272.	(Types.)
c. Great Barrier Reef.	„	92. 12. 1. 548.	
d. Rocky Island, Great Barrier Reef.	„	92. 12. 1. 262.	
e. Capricorn Island.	„	92. 12. 1. 273.	
f. Rocky Island, Great Barrier Reef.	„	92. 12. 1. 264.	

This last specimen (*f*) ought perhaps to be classed separately. In cœnenchymatous specialisation, and in the formation of the calicles it has all the characters of this type, but it has apparently been distorted by worm-tubes and now consists of an irregular tuft of rounded masses mixed with finger-shaped processes. The tips of the processes are an open reticulum in which worm-tubes may appear.

g. N. W. Australia. Admiralty. 92. 1. 16. 44.

This is a small fragment which has the same cœnenchymatous specialisation and formation of calicles, but is altogether on a smaller scale.

39. **Montipora foveolata.** (Pl. VI. fig. 1; Pl. XXXII. fig. 12.)

Montipora verrucosa, Quoy and Gaimard (*non* Lamarck), Voy. de l'Astrolabe, Zool., iv. (1834) p. 247, pl. xx. fig. 11.
Manopora foveolata, Dana, Zoophytes (1848) p. 507.
Manopora incrassata, Dana, op. cit., p. 503, pl. xlvii. fig. 1.
Montipora quoyi, Milne-Edwards and Haime, Les Poritides, Ann. des Sci. Nat., xvi. (1851) p. 55.
Montipora foveolata, Milne-Edwards and Haime, tom. cit., p. 66.
Montipora foveolata, Quelch, Chal. Rep., Reef Corals (1886) p. 176.

Description.—Corallum encrusting, massive, nodulated, with expanding edges, which are round and thick, either creeping over the substratum or free, and even rising above the substratum, supported by a well developed epitheca.

Calicles often very large (1·5 mm.), symmetrical, conspicuous when the corallum is viewed from above, crowded, on an average about the diameter of a calicle apart. Two cycles of thick septa, which are very short and nearly equal round the aperture, but, deeper down in the cavities, the primaries project well beyond the secondaries. The septa are continuous, toothed ridges strongly suggestive of laminæ; one (sometimes two) of the primaries conspicuously thicker and more prominent than the rest. The proper margins of the calicles hardly visible, their walls being often continuous with the interstitial elevations of the cœnenchyma. Each calicle is thus at the bottom of a well from 2 to 3 mm. deep. Young calicles may appear on the meeting points of the interstitial ridges. In this case, they are above the general level of the coral. On the smooth under surfaces, calicles of all sizes appear as deep open holes, with very slight traces of septa. These calicles are smallest near the epitheca, and get larger and larger till they reach the edge where, without break, they run into the calicles of the upper surface.

The cœnenchyma, in section, consists of a thick layer of close streaming reticulum bending downwards slightly on to the epitheca and upwards to form a thick layer, the upright elements of which often resemble typical trabeculæ. The interstitial spaces of the coral rise into tall thin ridges or plates, 3 to 4, even 5 mm. high. These are thin and lattice-like, with echinulate edges (the erect echinulæ being the tips of the upright elements of the reticulum); the plates themselves are triangular, semicircular, or finger-shaped. They are sometimes all

of the same height, size and thickness, and fuse together to form angular or circular ramparts round the calicles which are thus at the bottom of wells. The walls of the ramparts slope straight down into the polyp cavity, often without any shelf round the aperture of the latter. Where the ridges are incomplete, and vary in height and development, they give the surface a toothed appearance by being pointed and triangular.

On the under surface, the cœnenchyma forms a rather solid, bluntly echinulate, but otherwise smooth reticulum.

There are seven specimens of this coral, four of them from Tongatabu. These latter are of interest because they solve the mystery which has so long surrounded Quoy and Gaimard's type of the genus *Montipora*. These authors discovered a specimen with thin, toothed, triangular plates rising up in the interstices between the calicles; they made a sketch of it and then lost the specimen. They called it *Montipora verrucosa*. De Blainville proposed to identify it with Lamarck's *Porites verrucosa*. But the cylindrical papillæ characterising Lamarck's species could not be reconciled with the toothed and triangular plates shown in the original drawing of Quoy and Gaimard.

Milne-Edwards and Haime, after some hesitation, acknowledged the claim of Quoy and Gaimard's figure, renaming it *M. quoyi*. This hesitation was no doubt increased by the fact that both Lamarck's *verrucosa* and this mysterious coral came from Tonga and were perhaps after all specifically identical. Among the Montiporæ from Tonga, there are fortunately specimens of both *M. verrucosa*, Lamarck, and of *M. quoyi*, M.-E. This latter name, however, cannot be retained, because, prior to Milne-Edwards and Haime, Dana had figured and described two Montipores (Manopores) under the names *M. incrassata*, from the Fiji Islands, and *M. foveolata*, "probably" from the same place. Dana himself suggests that the former may be the same as the coral represented by Quoy and Gaimard's "doubtful" figure. The series of specimens in the National Collection warrants us in regarding Dana's two species as the same, the difference being merely that in *M. incrassata*, the plates are more purely triangular and pointed, whereas in *M. foveolata* they fuse to form ramparts round the calicles. These variations are found in one and the same specimen.

The most important specimen in the collection is a large massive frond, unfortunately broken into four pieces. It rises from a kind of stalk, bending over and expanding laterally like a leaf; the under surface is supported by a well developed, concentrically wrinkled epitheca. The upper surface sends up thick irregular processes, following masses of worm-tubes and calcareous algæ.

a. Tongatabu. J. J. Lister, Esq. 91. 3. 6. 41.
b. Tongatabu. „

Specimen *b* is a nodulated mass which can be fitted on to *a*. Both these specimens intertwine with gigantic calcareous worm-tubes (*b* is shown in the right-hand figure, Pl. VI. fig. 1).

c. Kandavu. H.M.S. 'Challenger.' 86. 12. 9. 262.

An irregular, circular, explanate growth, with humped surface, encrusting a previous growth (left-hand figure, Pl. VI. fig. 1).

d. Tongatabu. J. J. Lister, Esq. 97. 6. 18. 18.

Like the last but more convex, being cap-shaped. Under the cap, two corroded previous growths are traceable. The edge of the new growth tends to turn outwards horizontally.

e. Tongatabu. J. J. Lister, Esq. 97. 6. 18. 19.

A thick massive block with traces of five successive encrusting growths. The ramparts are here and there broken up into curved plates bordering the calicles. In a specimen from Rotuma Island, in the Cambridge University Museum, the same character is seen, groups of such calicles rising up into slight protuberances.

f, g. Kandavu. H.M.S. 'Challenger.' 86. 12. 9. 360. 92. 10. 16. 17.

These two specimens are small massive fragments with the calicles smaller than they are in the foregoing.

40. **Montipora socialis.** (Pl. V. fig. 4.)

Description.—Corallum massive and encrusting, without or with expanding edges, 0·5 cm. thick, when free supported by epitheca.

Calicles very conspicuous as deep round holes, less than 1 mm. diameter. The septa are short, thick, and regular, as continuous toothed ridges, twelve in number and nearly equally developed; the primaries are, however, distinguishable. One slightly thicker directive; fossa very deep and open. On the under side, between the edge and the epitheca, a very few small calicles as round deep holes. The margin of the calicles distinct in the bases of the interstitial ramparts.

Cœnenchyma shows in sections of expanding edges the streaming layer, very clear and delicate. Its bending upwards and downwards distinctly traceable. The upper layer, which is several cm. thick in massive growths, rises up in the interstitial spaces into flat thin ridges which, in fusing, seldom form ramparts round single calicles, but usually surround two, three, or more calicles in rows. The texture of the ridges is a light echinulate reticulum in which a regular palisade arrangement of the fine vertical elements of the reticulum is visible under a pocket lens. Young calicles appear on the slopes of the interstitial ridges like swallows' nests.

There are two fragments—broken edges—of this coral, which is evidently closely allied to *Montipora foveolata*. It differs from it, however, in the fact that more than one calicle opens in the bases of the troughs between the interstitial ridges, and that when only one opens its margin is distinct, i.e. the slope of the ridge does not dip down straight into the fossa, but there is a slight shelf marking the true aperture of the calicle.

Another peculiarity of these specimens is the appearance of minute young calicles on the sides of the ridges somewhat like swallows' nests, above the level calicles in the bases of the trough. The outer walls of such young calicles are thin and sometimes membranous.

As in *M. foveolata*, the ridges are, as a rule, thin, and here and there they are developed as

triangular plates or as free processes. Typically, however, they form, by regular fusion, the system of ramparts distantly reminding one of the convolutions of the Brain Coral.

a, *b*. Capricorn Islands. Coll. Saville-Kent. 92. 12. 1. 3–7. (Types.)

Two small fragments, apparently of a massive growth from a very different locality, may be provisionally placed here. They have many of the typical characters of the above, but differ in the fact that the interstices tend rather to form papillæ and triangular plates and do not fuse so freely as to form any definite systems of ramparts. They both appear to have been broken from the same stock, one from the more central portions and the other from the edge. The former would probably show best the typical features of the coral. On this fragment, the ramparts, when fully developed, are like those of the type, more than one calicle being walled round. Here and there ramparts round single calicles spring up above the general level as in *M. caliculata*.

c, *d*. Isle du Lise, Gloriosa Group. H.M.S. 'Alert.' 82. 10. 17. 191–196.

A portion of a massive stock from Rotuma, closely resembling the types, is preserved in the Cambridge University Museum.

41. **Montipora caliculata**. (Pl. IX.; Pl. XXXII. fig. 14.)

Manopora caliculata, Dana, Zoophytes (1848) p. 492, pl. xliv. fig. 1.
Montipora caliculata, Quelch, Chal. Rep., Reef Corals (1886) p. 177.

Description.—Corallum thick, explanate, with edges free, thick, and friable, surface throwing up massive protuberances. Epitheca developed only in patches under the free edges.

Calicles round, conspicuous, 1 mm. and under in diameter, often thickly crowded, situated in the bases of circular ramparts, in the swelling tops of which, in the angles between adjacent calicles, minute young calicles appear. Twelve short thick septa, often hardly distinguishable into primaries and secondaries. On the free under surfaces, calicles evenly distributed, numerous, of all sizes, from 1 mm. to mere specks, opening flush with the surface, surrounded by solid rings showing faint indications of twelve septal points.

Cœnenchyma shows, in the section of a free edge 8 to 10 mm. thick and about 1 cm. from the margin, a well developed reticular layer bending upwards and downwards; the layer formed by the bending downwards is more regularly trabecular than that formed by the bending upwards in which the reticulum is but little altered. In large explanate growths, portions of the corallum may be nearly smooth, the interstitial spaces being merely slightly swollen and rounded; elsewhere, however, the interstices may swell up into circular ramparts which, rising in groups, one opening at the side of and slightly above the other, give rise to solid upgrowths.

Dana described three Manopores (= Montipores) with protuberant calicles, viz. *M. gemmulata* (now *Turbinaria gemmulata*, Verrill), *M. lichen*, and *M. caliculata*. These,

according to Dana, formed a group with aborting calicles, transitional between the Madrepores and the more typical Manopores. As explained in the Introduction, p. 10, Montipores with protuberant calicles are certainly not common, and the protuberances, when present, as a rule differ fundamentally from those of *Madrepora*, *Turbinaria*, and *Astræopora*. In the foveolate group, they are not true calicles in Dana's sense at all, but arise as a complication of the rampart formation round immersed calicles. While appearing to be true protuberant calicle walls, they are, in reality, swellings of the interstitial spaces which carry up the calicles with them.

I have followed Quelch in giving Dana's name *caliculata* to specimens showing this peculiar development of foveolation; at the same time it should be noted that Dana's figure shows the individual calicles clear and distinct from one another, whereas the false calicles arising on the specimens now described, only exceptionally appear distinct; they are in reality circular pits in uprisings of the spongy cœnenchyma, and the real apertures of the calicles are in the bases of these pits. This explanation of these false calicles was clearly recognised by Quelch; when, therefore, he gave Dana's name to the 'Challenger' specimen he evidently concluded that the close resemblance which the false calicles have to true calicles had led Dana astray. It is unfortunate that Dana's single figure of the type is not supplemented by others showing more detail.

The largest specimen (*a*) showing this false-calicle formation is one of four (with a few fragments) from Torres Strait. The interstitial reticulum shows all stages of protrusion. Though smooth in patches, it surges up into papillæ and knobs over most of the surface. In the older parts of large explanate stocks, these latter rise in height into great swellings 5 to 6 cm. high, covered with sunken calicles. Similar excrescences from the surfaces of large stocks appear occasionally to break off and to give rise to detached masses which continue to grow vigorously. The two specimens, *d* and *e*, from the Torres Strait appear to have been such detached growths (cf. p. 66).

In addition to these there is a specimen which represents a small group of upgrowths, not unlike those on the Torres Strait specimens, broken off from its base. It is from Warrior Island, Great Barrier Reef. The primary septa in this specimen are slightly more pronounced than in the type, and the fresh upgrowths are more pointed.

In all the above cases false calicle formation is chiefly found on the knobs and upgrowths. In the remaining four specimens, however, it occurs over the whole surface. It is possible that the name *caliculata* should be confined to these. They are, however, only fragments, and may be only variations of growth of other corals. The largest (*h*) is closely allied to *M. turgescens*. The 'Challenger' fragment from Kandavu named *M. caliculata* by Quelch is very small and is interesting because it is clearly associated with the Kandavu specimens of *M. foveolata*. The specimen from New Guinea is interesting, because it shows the same general surface appearance (olive-green tinge combined with great delicacy of texture) which characterises all the New Guinea Montipores in the collection. The last specimen (*k*) is a small encrusting stock placed here tentatively; it is somewhat distorted by Balanids, but here and there the false calicle formation occurs.

a. Torres Strait.	Prof. A. C. Haddon.	97. 3. 9. 200. (Type.)
b, *c*. Fragments of specimen *a*.	„	„
d, *e*. Torres Strait (in masses which appear to have been detached).	„	„

f.	Young encrusting colony.	Prof. A. C. Haddon.
g.	Warrior Island.	Coll. Saville-Kent. 92. 12. 1. 340.
h.	Rocky Island.	Coll. Saville-Kent. 92. 12. 1. 260.
i.	Kandavu.	H.M.S. 'Challenger.'
j.	New Guinea.	Vienna Museum. 97. 6. 18. 30.
? *k.*	Macclesfield Bank, 15 fathoms.	Coll. Bassett-Smith. 93. 9. 1. 86.

Var. **piriformis.**

In addition to the above is a specimen which deserves describing by itself. It is a pear-shaped mass, attached by a comparatively thin stalk of corroded coral (genus unrecognisable). The top is broad and flat, and the whole must have been very top-heavy; the calicles are smaller than in the type, but have the twelve regular septa, and the light reticulum swells up irregularly so as to form groups of false calicles; the process, however, is so uniform that the whole mass retains its general symmetry. (See further Appendix.)

l.	Shortland Island, Solomon Islands.	Dr. Guppy. 84. 11. 21. 38.

42. **Montipora calcarea.** (Pl. X.; Pl. XXXII. fig. 13.)

Description.—Corallum a flat expanse with slightly turned-up edges, growing horizontally across the edges of previous growths, and over the tips of branched corals. A number of thin, digitiform processes (5 to 6 cm. high) rise from its surface, some singly, others fused into groups; a certain number of these are encrusting worm-tubes of various sizes. The epitheca in patches follows the growing edge, even curling up on to it. The living corallum protrudes through the epitheca in patches, probably for fresh points of attachment.

Calicles numerous, crowded, slightly sunk, as a rule less than their diameter apart, about 0·75 mm., conspicuous, deep, with very open fossa. Parts of two cycles of septa feebly and irregularly developed near the apertures, but in the shallower calicles, i.e. on the thinner parts of the corallum, either all or else the two directive septa fuse with a central irregular rod-like columella. On the under surface, the calicles are surrounded by continuous solid rings with slight points indicating the septa; here and there the rings trace out accurately the star-like shape of the aperture.

The cœnenchyma shows in section a typical streaming layer which is a rather loose open-meshed reticulum composed of stout threads and bands. This gives rise, both ventrally and dorsally, to much denser layers; the ventral layer, when resting on an epitheca, may become quite solid; elsewhere it is well developed and almost as thick as the upper layer. The surface of the cœnenchyma, in hollows and where growing rapidly, is a smooth reticulum; elsewhere the interstices are all slightly swollen and rendered noticeable by the presence of a thin knife-like ridge (sometimes double) rising up half-way between the calicles. These thin ridges which, when seen under a pocket lens, are very porous and irregular, may join together to form continuous irregular hexagonal patterns over patches of the surface. In their

extreme forms they are on the one hand faint white lines, on the other, ridges almost a millimetre in height. Single circular ridges may rise up round large calicles forming an open conical but shallow cup. Out of groups of such slightly protuberant calicles, erect, finger-like processes may arise 5 to 6 cm. high. As these thicken, thin secondary processes may again start from their tops. These finger-like processes, starting from protuberant calicles, differ from the cylindrical bent processes caused by the corallum-encrusting worm-tubes. Where the growth of these processes or of the edge of the corallum has been hindered, either by some external object, or perhaps by reaching the surface of the water, their tops are flat and spongy.

There is one large specimen with wavy edges (and two fragments) representing this type. It forms an irregular oval dish, horizontal, 40 by 30 cm., partly resting on the tips of a branching member of the same genus, *M. alcicornis*. This same habit has been described for *M. peltiformis*, but the two corals are quite different in the specialisation of the cœnenchyma. One peculiarity, after which I have named the specimen, deserves noting. The coral is in aspect curiously chalky, and has all the appearance of having been dead and slightly corroded when collected. As a rule, the cœnenchyma in the Madreporaria is composed of a smooth glistening substance; in this case it is all of a dull opaque white, and like the ordinary cœnenchyma when commencing to decompose. There is, however, no other sign of decomposition, and the finest reticulum is sharp and distinct when seen under a magnifying glass. Further, the branched coral (*M. alcicornis*) on which it rests has the same chalky appearance. On the other hand, the fragment described on p. 164 under the heading *M. hirsuta* looks as if it might possibly be the same coral only not corroded (cf. remarks there made).

The peculiar feature of the type is the formation of the thin keels along the ridges of the swollen interstices. These are most marked on the upright processes, due to continued budding from the walls of the ramparted calicles. This same method of formation of processes takes place in *M. caliculata*.

a. Tonga (with *M. alcicornis*). J. J. Lister, Esq.* 91. 3. 6. 28. (Type.)

43. Montipora irregularis.

Montipora irregularis, Quelch, Chal. Rep., Reef Corals (1886) p. 173, pl. viii. figs. 4, 4*a*.

Description.—Corallum a loosely branching mass with irregular encrusting base, the edges of which creep downwards, covering the former growth, and are rarely free; the cylindrical or slightly flattened branches twist and curl out of the perpendicular, fusing to form arches and other irregular shapes; the growing tips are mostly thin and sharply or bluntly tapering. The branched processes rise 10 to 12 cm. above the encrusting base.

The calicles are conspicuous, crowded, largest (1 mm.) on the encrusting base and thick branches, but less on the thinner processes and tapering points, generally less than their diameter apart. The margin is often a narrow, smooth, flat, white rim lying in the base of the rampart, and from the edge of which the septa project like echinulæ, often sloping upwards.

* This specimen was purchased by Mr. Lister in Tonga, and no information can now be obtained as to its exact locality or condition when collected.

Primaries thin, reaching to the half radius circle, conspicuous; one, sometimes two, directives visible to the naked eye; secondaries irregularly developed; fossa deep.

The cœnenchyma shows in section a thin axial reticulum which is open and angular. This is surrounded by a dense radiating reticulum, which rises up in the interstitial spaces as a regular system of ridges, sometimes sharpened into thin thread-like keels. The surface is a delicate, open, slightly flaky reticulum, the tips of the threads pointing in all directions as fine echinulæ, the septa being conspicuous radial groups of reticular points.

The single large type specimen differs chiefly in the manner of growth from the next type *M. multiformis*. The interstitial ridges are also not so thick and woolly. The calicles appear more crowded, and the branching processes are more regularly cylindrical with tapering points. These differences are sufficient justification for classing them separately. Quelch compared the specimen with Brüggemann's *M. divaricata* and Dana's *M. digitata*, but these are almost purely glabrous forms, and differ very widely in almost all important points.

a. Zamboanga. H.M.S. 'Challenger.' (Type.)

44. **Montipora multiformis.** (Pl. VII.; Pl. VI. fig. 4; Pl. XXXII. fig. 7.)

Description.—Corallum encrusting, with free edges, expanding or rising into knobs or erect processes which fuse irregularly; epitheca under creeping and sometimes also under free edges. Successive incrustations of former growths with regularly knobbed surfaces give rise to great shapeless mounds full of hollows.

Calicles crowded, sunk, rather less than their diameter apart; star-like, varying greatly in size, from 1 mm. on eminences to 0·5 on slopes and in the valleys. The apertures of the larger calicles bounded by a continuous border from which the six primaries project well into the fossa; the secondaries are only points. Directive septa visible to the naked eye; one of these in the larger calicles may be very thick, exsert, and not infrequently laminate. Where the calicles are very crowded their margins may be incomplete, and the stars irregular, some being like minute pin-holes. On the under surface, the calicles are small and circumscribed by a continuous ring marked off from the looser interstitial cœnenchyma; this distinctness is, however, gradually lost as the under surface becomes denser and more solid.

Cœnenchyma. In section the typical streaming layer shows traces of lamination. Its elements bend upwards and downwards towards the upper and lower surfaces of the coral. As the upper layer thickens, i.e. in the older portions of the stock, the vertical elements of the reticulum look like trabeculæ. At the surface, this reticulum ends in bold, jagged flakes, stout and sharply cut yet not crowded, so that the reticulum is not dense. The reticulum everywhere (except in the level bottoms of the valleys which are crowded with irregular calicles) swells up between the calicles. The ridge thus formed may be round and low, or else have a slight median keel. The whole surface has a woolly appearance owing to the open character of the reticulum of these raised ridges. The knobs and processes are

formed by the protrusion of groups of calicles with specially swollen interstices; these rise higher and higher and become irregularly lobed.

This foveolate Montipore is not far removed from Quelch's *irregularis*. Its swollen interstices are more rounded and the reticulum is more open, and none of the specimens form the long, tapering, cylindrical, freely branching processes of the latter.

The type specimens are from Western Australia, and are flat creeping masses with irregular edges, mostly free, and 3 to 4 mm. thick. The surface of the larger specimen (*a*) is 30 cm. across and covered with vertical processes, the lower being round thick knobs, the taller being irregularly lobed and rising as high as 6 cm. A rich rose-pink suffuses many parts of the coral, especially the growing edges and the tips of the processes.

a, *b*. Houtman's Abrolhos. Coll. Saville-Kent. 95. 10. 9. 57, 52 (Types.)

(2) Fragments representing free lobed edges detached from large stocks.

c–*e*. Houtman's Abrolhos. Coll. Saville-Kent. 95. 10. 9. 60, 48, 47

(3) An irregular creeping mass distorted by commensal Balanids and by attached molluscs.

f. Houtman's Abrolhos. Coll. Saville-Kent. 95. 10. 9. 55.

(4) A distorted portion of the edge of an explanate stock remarkable for the exuberance of its cœnenchyma.

g. Houtman's Abrolhos. Coll. Saville-Kent. 97. 6. 18. 20.

(5) A small explanate stock, attached to dead portion of a former growth.

h. Houtman's Abrolhos. Coll. Saville-Kent. 95. 10. 9. 62.

(6) Two large specimens, apparently old stocks, which show the living, encrusting and lobed coral creeping over dead former growths, not closely applied but arching irregularly over the old branches so that loose mounds are formed over 20 cm. high, full of great cavities. (Pl. VII.). The larger specimen (*i*) illustrates the process, for one side is growing vigorously and throwing up great lobate knobs. This vigorous portion of the colony has already begun to creep over the less vigorous portion on the opposite side, which, though living when gathered shows signs of decay—portions of it, indeed, were already dead.

i, *j*. Houtman's Abrolhos. Coll. Saville-Kent. 95. 10. 9. 61, 56

(7) Small masses consisting mainly of clumps of branches, the secondary branchings being rather more delicate; on these branches the calicles tend to be small. The tips of these richly branched masses are chiefly formed by the rosy pink streaming layer. These specimens show

the transition between the creeping and the purely branching related forms. Specimens *m* and *n* lead on to the next group (8).

k–n. Houtman's Abrolhos.	Coll. Saville-Kent.	95. 10. 9. 46, 44, 50

(8) *Detached Fragments.*—Three specimens, which comparison with the above series shows to be merely detached portions of this coral growing as free and independent stocks, are so different that they deserve to be described in detail. I originally described them as varieties of the type. (Pl. VI. fig. 4.)

Description.—Corallum a thick, more or less circular disc consisting of a compact tuft of thin processes, swollen at their tips and radiating upwards, outwards, and downwards; upon these the specimens rest.

Calicles conspicuous, numerous, evenly distributed, about 1 diameter apart, 0·75 mm., sunk in a delicate, open, thread-like reticulum. Two cycles of septa; the primaries conspicuous, reaching to about the half radius circle; the secondaries about half as long.

The cœnenchyma is much more delicately reticular than in the attached stocks. At the growing swollen tips of the processes, the partially laminate streaming layer may appear at the surface forming delicate line patterns. Elsewhere, the reticulum is delicately filamentous and open, the ends of the threads pointing as elegant spikes in all directions. The upper portions of the corallum, when level, show the same characters as are above described for the type.

These are not the only specimens of detached portions of Montipores growing freely. (See *M. indentata.*) It is interesting to note that these free stocks rest on the swollen ends of processes which grow out freely in all directions. I at first thought that this method of growth in these specimens of *M. multiformis* was due to the presence of crabs dwelling in the recesses of the stock, but there are no traces of such lodgers in the free specimens of *M. indentata.*

p. Houtman's Abrolhos.	Coll. Saville-Kent.	95. 10. 9. 51.
q, r. King's Sound, West Australia.	„ „	95. 10. 9. 78–77.

45. Montipora angulata.

Porites angulata, Lamarck, Hist. Anim. sans Vert., ii. (1816) p. 271.
Montipora phrygiana, Milne-Edwards and Haime (non Esper), Ann. d. Sci. Nat., (3°) xvi. (1851) p. 61.

Description.—Corallum (complete form unknown) consists of flattened processes with sharp angular edges, and of short explanate leaves curled up. Processes from 2 to 6 mm. thick.

Calicles are conspicuous, slightly more than 0·5 mm. in size, with clearly cut margins. The primaries are somewhat unequal and blunt, the secondaries feebly developed and few in number.

The cœnenchyma is loose and spongy, dense in section, but the surface reticulum is rather smooth and flaky, perforated with round pores. It rises into sharp angular ridges between the calicles on the broad faces of the leaves or branches; and usually surrounding the calicles with a polygonal rampart. These are specially prominent in the lower portion of the corallum; on the upper and young portions they first appear as underlips.

Lamarck's original type of this coral is preserved in the Paris Museum. Of the five small fragments, that numbered 256*a* is certainly one of the specimens referred to by Lamarck. It is a very markedly foveolate Montipore, the ridges being clean, sharp, and smooth. But not only do the interstitial ridges suggest the name *angulata*, but the edges of the growth are also sharp and angular.

On Milne-Edwards' suggested identification of this with Esper's *Madrepora phrygiana*, see p. 133.

Milne-Edwards also suggested that de Blainville's *Heliopora angulosa* (Manuel, p. 392) is synonymous with Lamarck's type.

Locality, "Eastern Ocean." Type in Paris Museum (No. 256*a*).

b. Ramosæ.

46. **Montipora gaimardi.** (Pl. IV. figs. 5, 6; Pl. XXXII. fig. 17.)

? *Montipora poritiformis*, Verrill, Proc. Essex Inst., v. (1866) p. 26.

Description.—Corallum forms small compact tufts of more or less cylindrical branches (from 1 to 0·5 cm. thick); these may taper off to a point or the tips may flatten and break up into several small points.

Calicles are conspicuous (small, 0·5 and less), uniformly crowded, about 1 diameter apart, with six prominent, usually thick and slightly exsert septa, often more or less laminate, one or two directives; the second cycle also often regularly and symmetrically developed, but thinner than the primaries. The septa often have T-shaped thickenings peripherally. These may all unite to form a smooth rim right round the margin of the aperture.

The cœnenchyma shows in section a thick axial strand of open reticulum which takes the lead in the carrying up of the branches either as tall tapering points or as rounded or slightly compressed knobs. The branchings are due to the dividing up of this axial reticulum. The axial layer is surrounded by a much denser cortical layer of no great depth and often rather sharply marked off from the axial layer. At the surface the interstitial spaces tend to swell into ridges which uniting give rise to a pronounced foveolation. These ridges frequently run out into slight papillæ at their points of intersection. On some specimens, these ramparts may be high, and the calicles be sunk in a richly foveolate surface. On other specimens the surface is evenly and slightly foveolate on one side, smooth and stony on the other.

Under this heading I have grouped ten specimens which appear linked together, although they vary greatly in details. They all, however, agree in being tufts of branches covered with small crowded calicles with their six exsert septa. These latter are visible to the naked eye. The tendency of the interstitial cœnenchyma to rise into foveolate ridges, and even into points and plates, varies greatly; on some specimens, one side of a branch is smooth (Pl. IV. fig. 6) while the opposite side is roughened by interstitial swellings. Again, the interstitial ramparts may be either reticular or else a delicate arrangement of flakes and granules (see Pl. XXXII. fig. 17). This last mentioned variety has a most remarkable superficial resemblance to *Porites*. On the specimens which form compact tufts of short branches, the interstitial upgrowths are usually very marked, giving the whole coral a rough look (see Pl. IV. fig. 5).

Of these specimens, I at first thought that the two from the Solomon Islands, which were quite smooth on one side, might be *M. rubra*, Q. & G. They were, however, linked on by the foveolation on the opposite side, and by the characters and distribution of the calicles, to seven other specimens from Tongatabu characterised by a very rich foveolation. These eight specimens appeared to form a natural group which could hardly be identical with *M. rubra* (for the characters of this latter type, see p. 45). Lastly, there is another specimen (*j*) which had been identified by Brüggemann as *M. digitata*. This may be one of the smoother varieties having the same conspicuous primaries.

The suggested synonymy with *M. poritiformis* of Verrill is due to the resemblance above noted of some of the specimens to a branching *Porites*. Verrill's species was, however, from the Loochoo Islands. It is worth noting that Brüggemann also emphasised the close connection between his *M. digitata* (*j*), his *M. superficialis*,* and Verrill's *M. poritiformis*.

a, *b*. Solomon Islands.	Vienna Museum.
c–*i*. Tongatabu.	Coll. J. J. Lister.
j. ? Australia.	[Register No. 97. 6. 18. 29.]

47. **Montipora indentata.** (Pl. V. fig. 5; Pl. XXXII. fig. 5.)

Description.—Corallum ramose; single cylindrical stems, 1 to 1·25 cm. thick, shoot up for 2 to 3 cm. and then expand suddenly into a clump of thick irregular branches. The stem may be slightly flattened, and then the clump of branches may spread out as an irregular palm-leaf. The branchlets are 6 to 7 mm. thick.

Calicles irregular, star-shaped, 0·75 mm. diameter, opening in the bases of slight depressions. Septa irregularly developed, portions of two cycles, laminate exsert directives not infrequently in connection with surface granules. Fossa inconspicuous.

Cœnenchyma shows in the section of a branch an axial, coarse, filamentous reticulum, surrounded by a slightly denser cortical layer, the transition being gradual. The cortical layer is composed of short, irregularly thickened trabeculæ. Near the base of the stem, the whole section becomes so dense as to obliterate the distinction between the two layers. On the surface of the branches, the coarse reticulum surges up between the calicles as large

* *Vide antea*, p. 46.

angular granules. The depressions in the bases of which the calicles open are shallow. On the stems, the cœnenchyma is much denser, and the pits wider and shallower, but very uniform.

There are four ramose specimens of this foveolate type, and two which appear to have been broken off and to have continued to grow as free unattached colonies. This detached method of life considerably alters the whole habit and aspect of the stock. But the evidence which induces me to associate these two free stocks with the type is fairly conclusive. The larger one is too large to roll about freely, and is, therefore, altered least; that it belongs to this type, close comparison leaves but little doubt; the smaller can be seen to be but an advance on the last named, in that all the peculiar features of the large specimen which differentiate it from the type are carried to an extreme, there being no resemblance to the type left. But for the larger free stock, the smaller would have had to be classed by itself.

The peculiar growth of the free stock is the same as that described for the detached growths of *M. multiformis* (p. 63). They all show a tendency to send out processes radially in all directions to form globular masses. If the detached mass is heavy, see specimens *d*, *e* of *M. caliculata*, these processes only radiate out from the upper and lateral surfaces, but if small and light, they radiate out in all directions, the mass resting upon the tips of those which happen to point downwards. These tips are generally somewhat swollen and rounded, and consist of a rapidly growing reticular cœnenchyma.

a. Great Barrier Reef.	Coll. Saville-Kent.		92. 12. 1. 537.	(Type.)
b, *c*, *d*. Great Barrier Reef.	„	„	97. 6. 18. 31. 32. 33.	
e. (Detached stock) Great Barrier Reef.	„	„	92. 12. 1. 535.	
f. (Detached and freely rolling stock) Great Barrier Reef.	„	„	92. 12. 1. 521.	

48. Montipora palmata.

Manopora palmata, Dana, Zoophytes (1848) p. 493, pl. xliv. figs. 2, 2*a*–2*f*.
Montipora palmata, Milne-Edwards and Haime, Ann. d. Sci. Nat., (3°) xvi. (1851) p. 63.
Montipora palmata, Quelch, Chal. Rep., Reef Corals (1886) p. 171.
Montipora rubra, Quelch (non Q. & G.), op. cit., p. 172.
Montipora levis (variety), Quelch, ibid.

Description.—Corallum forms variously shaped tufts, 10 to 11 cm. high, of thin branches 5 to 8 mm. thick, often flattened and expanding at their tips, fusing irregularly. Old stocks which have been regrown over, may form small massive clumps sending out irregular branches.

Calicles small, 0·4 mm., numerous, less than 1 mm. apart, conspicuous on the lower and smoother portions of the stock, obscured by the cœnenchyma on the upper and younger portions. Aperture sharply circumscribed, being apparently cut out of solid cœnenchyma,

with six clear, round, petaloid, interseptal loculi, not always symmetrically arranged, and with occasional rudimentary septa of the second cycle faintly indicated.

Cœnenchyma in sections of younger branches shows a thin axial streaming layer, delicate and open, in sharp contrast with the radial or cortical layer which tends at once to be dense. In older branches, both elements are very dense, and the cortical layer is thick and very solid. On the surface, the cœnenchyma sends up on the younger branches ragged flakes which tend to form what appear to be thin, protuberant underlips to the calicles; but these really rise from the middle of the interstices, and as the branches thicken grow right round as low, almost hexagonal ridges, often in sharp contrast to the level solid layer out of which the calicular aperture is cut. To the naked eye, these ridges look solid, but under the lens they appear beautifully serrated and frilled.

Dana's figures and description apply exactly to a specimen from the Fiji Islands which was accordingly identified as *M. palmata* by Quelch. There were, further, four other specimens also from Fiji which are not quite so typically palmate and which were named by Quelch *M. rubra*, Q. & G. These show, however, the same specialisation of the cœnenchyma, and cannot be separated from the palmate specimen above alluded to. The differences may be accounted for by different stages of growth; the more ragged palmate specimen is altogether younger and in more vigorous growth, and the surface cœnenchyma has not yet assumed the final character above described. Examination of its dead basal part shows that this identification is correct, for the corroded calicles can be easily seen to be enclosed within the typical, clear, sharp, hexagonal ridges running down the middle of the interstices.

Lastly, a specimen labelled "*Montipora levis, variety*" seems to me to be closer to this type than to *M. levis*, although the protuberant interstices are obscured and the whole cœnenchyma is thick and dense. The calicles are alike, and on the sides of the stem there are clear traces of the formation of the typical ridges surrounding flat polygonal areas.

The resemblance of some of the smaller and thinner branches with their nariform protuberant ridges to the branches of Madrepores is very striking.

In his figure 2*b*, Dana represents an enlarged polyp fully expanded, the twelve tentacles like equal, flat, marginal lobes coloured alternately brown and light blue, the former being the general colour of the animal, the latter forming a thin band round the oral aperture.

For Quelch's suggested affinity between this type and his *M. fragilis* see p. 139.

a. (An old clump) Fiji Reefs.	H.M.S. 'Challenger.'	86. 12. 9. 283.
b. (Stock with fresh tip in rapid growth.)	„ „	86. 12. 9. 257.
c. (Young stock encrusting corroded previous growth.)	„ „	
d, *e*, *f*. (Portions of small stocks.)	„ „	
g. (With typical characteristics greatly obscured.)	[Register No. 86. 12. 9. 358.]	

49. Montipora rigida.

Montipora rigida, Verrill, Proc. Essex Inst., v. (1866) p. 26.
Non *Montipora rigida*, Quelch (see *Montipora compressa*, p. 42).

Description.—Corallum branched, the branches strongly compressed, thin at the summits, forming flattened clusters of branchlets coalescent below.

Calicles small, 0·75 mm., septa imperfectly developed, six in number, "trabecular" and "spinose."

Cœnenchyma unusually dense, uneven, strongly echinulated, with numerous rounded pores. The interstitial spaces rise up to form cell-like ramparts which are "thin and angular" round the calicles, "giving the surface the appearance of some Madrepores with short open corallites."

The above is a recasting of Verrill's description of a branched Montipore from Bonin Island. The broadened ends of the branches measured 12 mm. across by less than 6 mm. in thickness. The fragments were about 7·5 cm. high, and the colour dull yellowish brown.

The most important character here described is certainly the swelling up of the interstices to form ramparts, giving the stock the appearance of a Madrepore. This character is not visible in the specimens from Mactan Island, brought by the 'Challenger,' and identified by Quelch with this type, but here identified with the *M. compressa* of Esper.

In describing a branched foveolate Montipore from Ponapè, Brüggemann suggested that Verrill's type might be the same as *Madrepora limitata*, Ellis and Solander. The description given by these authors certainly appears to refer to a branched foveolate Montipore, but there is no locality given nor any further details. On the other hand, a very great number of the branched Montipores tend to develope the foveolate specialisation of the cœnenchyma. I do not, therefore, feel justified in following Brüggemann in this synonymy.

There are, unfortunately, no specimens in the National Museum which I can identify with this type.

50. Montipora limitata.

Madrepora limitata, Ellis and Solander, Zoophytes (1786) p. 172.
Montipora limitata, Brüggemann, Journ. Mus. Godef., v. (1879) p. 208.

Description.—Corallum branched; branches slightly compressed.

Calicles scattered, with rough interstices forming boundaries ("limites") between the calicles.

This description appears to refer to a foveolate Montipore, but it is impossible, without locality, even to suggest its affinity. See above for Brüggemann's proposed identification of it with Verrill's *M. rigida*.

Group IV.—PAPILLATE.

a. Papillæ irregular.

51. Montipora venosa. (Pl. XXXII. fig. 15.)

Porites venosa, Ehrenberg, Korallenthiere (1834) p. 118.
Manopora venosa, Dana, Zoophytes (1848) p. 501.
Montipora explanata (partim), Brüggemann, Phil. Trans., clxviii. (1879) p. 577.
Montipora tuberculosa, Klunzinger (non Lamarck), Corallenthiere, pt. ii. (1879) p. 32, taf. vi. 4, v. 13, x. 4.
Montipora verrucosa, Id. op. cit., p. 35, taf. vi. 10, v. 14 and 15, x. 7.
Montipora scabricula, Quelch (non Dana), Chal. Rep., Reef Corals (1886) p. 177.

Description.—Corallum thick (1 to 2 cm.), encrusting, tough and heavy, one thick layer over the other forming great massive nodules. Free edges with or without epitheca.

Calicles small, 0·5 to 0·75 mm. The primaries short and stout, with directives sometimes pronounced, when they may be laminate; secondaries faintly developed; two or more primaries fuse far down in the fossa with a solid columella-like body. Fossa deep and open.

Cœnenchyma a compact reticulum forming a solid layer upon the epitheca; the thickening layer is conspicuous as an upward streaming of a compact reticulum without any distinct trabeculæ. At the surface, the reticulum foams quite irregularly upwards, as single papillæ, as rings round calicles, or as small patches with smooth valleys or depressions between them. When these are very deep, the calicles in their bases may be crowded and minute. The ends of the reticular threads rising up to form the papillate swellings sometimes end as free bushes of short fine branchlets. This delicate branching is not always apparent, the threads being more compactly arranged into reticular papillæ.

There are five specimens which are grouped under this heading. They all differ, but yet lead on to one another. They lead on also to the early type "*spumosa*" of Lamarck, which is also characterised by the irregular foaming of the interstitial cœnenchyma.

Three of these specimens are from Dr. Klunzinger's collection, and were labelled by him *M. verrucosa*, Lam., *M. tuberculosa*, Lam., and *M. tuberculosa var. cærulea*. The first named of these was further identified by him with Ehrenberg's type *Porites venosa*, preserved in the Berlin Museum. Hence this name must be applied to the group, since neither of the earlier Lamarckian names seems to apply. In the original measurements given by Dr. Klunzinger, the size (2 mm.) of the calicle really applies to the apertures of the papillate ramparts in the bases of which the calicles are sunk.

The first specimen, identified by Dr. Klunzinger as *Porites venosa*, Ehr., is 1·5 cm. thick, and the papillate formation is more pronounced than in any of the following. The lobuli formed by the papillate upsurging of groups of interstitial spaces together are separated by deep narrow valleys, the level bottoms of which are thickly dotted over with minute calicles.

The specimen was labelled by Dr. Klunzinger *M. verrucosa*, Lamarck. The colour of the colony in life is a greyish yellow.

a. Koseir. Dr. Klunzinger. 86. 10. 5. 28. (Pl. XXXII. fig. 15.)

In the next specimen the last growth forms a cap over the one which went before it, and the calicles are more regularly star-shaped, the slightly finer cœnenchyma showing itself in the more slender and less bluntly granular septa. This is one of Dr. Klunzinger's specimens of *M. tuberculosa* (see, however, p. 112). The colour of the living coral, as seen by Dr. Klunzinger, is described as yellowish passing into grey-green. It flourishes in the surf. Hence, probably, its toughness noticed by Dr. Klunzinger.

b. Koseir. Dr. Klunzinger. 86. 10. 5. 32.

The third specimen, labelled "*M. tuberculosa*, Lamarck, *var. cærulea*," differs from the last in the greater size of the papillæ, due apparently to the greater distance apart of the calicles.

c. Koseir. Dr. Klunzinger. 86. 10. 5. 53.

The fourth specimen is the simplest form in the group, and is one of Brüggemann's type specimens of *M. explanata*. There were in all three of these types: one, being glabrous, has for obvious reasons retained the name; the other two are respectively papillate and tuberculate (see *M. perforata*). The papillate stock is thick and explanate, closely encrusting a previous growth, which had everywhere died down, but was not completely covered. At one place, viz. the highest point, the young and the old growths are continuous; the new corallum creeping down the slopes over the old, both being about 1 cm. thick. The starting of new growths at the highest points of old and dying stocks has been frequently observed by me in both *Turbinaria* and *Astræopora*.

The calicles are very numerous and evenly distributed, being about 1 diameter apart. The cœnenchyma rises either in the form of small papillæ or else the wall of the calicle rises somewhat as in *M. caliculata*; groups of such raised walls making the surface lobulate. This is the most solid of the specimens.

d. Locality not recorded. [Register No. 97. 6. 18. 31.]

The fifth specimen which appears to belong to this group is one of the 'Challenger' corals from the Fiji Reefs, and was identified by Quelch with Dana's *M. scabricula*. The humps and lobes shown in Dana's figures of this latter type (Zoophytes, p. 502, pl. xlvi. figs. 3, 3*a*, 3*b*) are much too smooth and regular to represent the irregular broken surface of this specimen, broken, that is, by papillæ or by patches of fused papillæ arranged so as to form false calicles. So numerous are these false calicles that I doubt whether this specimen should not be classed separately somewhere near *M. caliculata*.

e. Fiji Reefs. H.M.S. 'Challenger.' 86. 12. 9. 251.

52. **Montipora spumosa.** (Pl. VIII. fig. 1; Pl. XI.; Pl. XXXII. fig. 16.)

Porites spumosa, Lamarck, Anim. sans Vert., 2nd edition, ii. (1816) p. 273.
Montipora spumosa, de Blainville, Manuel (1834) p. 389.
Porites venosa, Ehrenberg, Korallenthiere (1834) p. 118 (see Klunzinger).
Non *Manopora spumosa*, Dana, Zoophytes (1848) p. 495, pl. xliv. fig. 1.

Description. — Corallum encrusting, massive or running up into tall branching lobes covered with small calicle-bearing knobs. An epitheca is everywhere developed under the creeping edges.

Calicles immersed below level of cœnenchyma, closely and evenly distributed over the whole corallum, even on the tips of the knobs, about a diameter apart, under 1 mm., star-like when seen directly from above. Two cycles of septa; primaries short and thick; the secondaries are like notches in the square interseptal loculi; fossa deep.

Cœnenchyma in section purely reticular, although, in the encrusting forms, the thickening layer may sometimes become almost trabecular. This reticulum rises everywhere between the calicles as a rather coarse flaky network, the flakes standing up, twisted and with jagged edges. These interstitial upgrowths are quite irregular: at one point, they spring up carrying the surface up into humped knobs, or even lobed branches; while, between such excrescences, small areas of the cœnenchyma are often perfectly smooth.

There can, I think, be little doubt that under this name Lamarck was describing and naming the coral figured by Knorr in his 'Deliciæ Naturæ Selectæ.'* The coral which that figure is meant to represent seems not to have been recognised again, for while de Blainville merely adopts it as a Montipora (*spumosa*), Dana gave Lamarck's name to a very different coral (see *M. hispida*) and Milne-Edwards suppressed it, making it synonymous with *Montipora monasteriata* of Forskål. The figures given in Knorr's plates are, as a rule, sufficiently true to life, and lead us to believe that any particular figure represents the essential features of the object delineated. Fortunately, there is a specimen in the National Collection resembling in all essentials Knorr's figure, which thus justifies us in re-establishing Lamarck's *spumosa* (see Pl. VIII. fig. 1).

The essential feature in this type appears to be the irregular rising up (foaming) of the interstitial cœnenchyma to form knobs and lobes which may grow into branches. The corallum commences as a creeping encrusting growth, which may develop more or less evenly in thickness, the surface being humpy and knobbed, or merely greatly roughened by the irregular upgrowths of the cœnenchyma. From such forms, branched lobate masses can easily be deduced. The branches form thick gnarled or knobbed cylinders, or else clumps of thinner irregular upgrowths, or again the whole corallum may tower upwards in solid castellated masses, not separating into branches at all. (Pl. XI).

There are in the collection eighteen specimens which I have found it expedient to arrange under this heading, in spite of the variations which they show. They all agree in this irregular foaming of a reticular interstitial cœnenchyma.

* Nürnberg, 1772, pl. A_1, fig. 4.

a. A large irregularly branched specimen from Tongatabu, which appears to me to come very near to Knorr's figure, on which the type was founded by Lamarck. I know of no other Montipore covered with more or less smooth rounded knobs full of calicles such as is shown in that figure. The specimen itself seems to have been built up by successive encrustations. As any portion dies, it is grown over by a thin layer, the tips of the branches being carried higher by the surging up of the coral into small thin lobes not unlike those of the next specimen.

b. A smaller branched stock, the branches being thinner and more symmetrically cylindrical. This condition may be due to the fact that the stock is young, whereas *a* is older and has been gnarled and knobbed by successive encrustations.

a, b. Tongatabu. J. J. Lister, Esq.

Three encrusting masses of the same which have not formed branches. Edges thin, sometimes free and supported by an epitheca.

c, d, e. Tongatabu. J. J. Lister, Esq.

An irregular clump of lobate branches.

f. Rocky Island, Great Barrier Reef. Coll. Saville-Kent.

A great, solid, castellated mass, towering upwards irregularly for some 50 cm. or more, and showing the essential characters claimed for the type. The knobs are, however, not so rounded or distinct. *h* is a fragment of the same, fitted into its place.

g, h. Lacépède Island, North-West Australia. Coll. Saville-Kent.

A portion of a large, horizontal, explanate specimen, which appears to be either a young stage of *g*, or else a horizontally growing edge of a large stock. The whole upper surface rises up into a number of upright lobate processes. These are so crowded that they leave hardly any portion of the corallum smooth. They are of all heights, from a few mm. to 4 cm.

i. Lacépède Island, North-West Australia. Coll. Saville-Kent. 93. 11. 8. 15.

A thin encrusting specimen with small star-like calicles. The surface is greatly roughened by the regular uprisings of the cœnenchyma, which are here and there simple papillæ. This is probably a young specimen of the two last.

j. Lacépède Island, North-West Australia. Coll. Saville-Kent. 93. 11. 8. 16.

A small fragment of an explanate growth which may perhaps belong here.

? *k*. Arafura Sea. Admiralty. 92. 4. 5. 41.

Two small fragments of massive specimens which also appear to belong to this type, and were labelled by Brüggemann, "near *expansa*."

l, m. Keeling Island. H. O. Forbes, Esq. 84. 2. 16. 3–4.

A doubtful encrusting specimen of very irregular shape and not unlike the specimens *c, d, e*, but the calicles are much smaller and further apart, and the reticulum is closer.

? *n*. Rocky Island, Great Barrier Reef. Coll. Saville-Kent. 92. 12. 1. 12.

53. **Montipora ænigmatica.** (Pl. VIII. fig. 2; Pl. XXXII. fig. 18.)

Montipora papillosa, Bassett-Smith (*non* Lamarck), Ann. and Mag. Nat Hist., 6° vi. (1890) p. 450.

Description. — Corallum explanate, complete form unknown, apparently a large, thin, horizontal plate; 2 mm. thick at edge, 7 to 8 mm. at 14 cm. from edge, very dense and heavy; epitheca feebly developed far from growing edge.

Calicles not easily distinguishable to the naked eye, from 0·50 mm. across, star-shaped; six prominent but irregular septa stretching far beyond the half radius circle, and generally with a few rudimentary secondaries. Fossa and interseptal loculi only distinguishable under a pocket lens by their star-shaped arrangement from the open meshes of the interstitial reticulum. On the under surface, the calicles are smaller, ca. 0·40 mm., and mostly on the summits of small blunt conical processes, or else the aperture with its septa rises like a low disc above the surface. These give the otherwise smooth solid under surface a pimply appearance.

Cœnenchyma in section is very dense, the streaming layer being a coarse reticulum. It dips slightly ventrally to form the dense tissue of the under surface, and rises dorsally into a thick dense layer, the reticular threads being very thick. On the upper surface itself, the threads are not yet thickened, and they there form a perfectly level, loose, open filamentous network. The papillæ are quite irregular in shape and distribution; they average 2 mm. diameter and 1 mm. high. No relation between them and the polyp cavities can be made out, although the latter sometimes open low down on the sides of the papillæ. Wherever the tips of the papillæ, or indeed the surface cœnenchyma, has been rubbed off, the stout reticulum of the underlying tissue is visible.

This specimen, which was labelled *M. papillosa* by Mr. Bassett-Smith, differs from that type as figured by de Blainville in not having the papillæ arranged in any longitudinal series —a feature emphasised by Lamarck (see *M. papillosa*). Indeed, in this coral, the papillæ do not appear at all near the growing edge, which is smooth and solid looking. Further, the whole character of growth appears to differ from that of *M. papillosa*, the calicles of which are very distinctly shown in de Blainville's drawing, whereas they are hardly visible to the naked eye in this coral. The specimen represents a large, thin, triangular sheet of an old dead frond, across the middle of which a new layer of living coral has spread. There is nothing to show how the frond was originally attached. From its weight and solidity we may conclude that it was a horizontal growth. The dead portion had become very solid and stony.

a. Tizard Bank, China Sea. H.M.S. 'Rambler.' (Type.)

54. **Montipora Brueggemanni.** (Pl. XXXII. fig. 19.)

Description.—Corallum in its complete form unknown, explanate, 1 to 1·5 mm. thick at the growing edge, 2·5 mm. thick 4 cm. away. A wrinkled epitheca follows close behind the growing edge.

Calicles minute, from 0·3 to 0·5 mm., very scattered, to the naked eye very irregular in shape, some as mere shallow scratchings of the surface cœnenchyma. Under the lens, they are star-shaped, being most regular in the thicker part of the corallum, with deep fossa. Six prominent septa, very unequal in thickness and size; the interseptal loculi run into the open spaces of the surface network.

In section the streaming layer is distinct, formed of a few thick cylindrical threads. This forms a thick solid layer on the epitheca; while towards the upper surface the threads of the reticulum bend sharply up, resembling short, thick and very irregular trabeculæ. This thickening layer rises here and there into irregular mounds which vary from faint ridges to stout conical eminences nearly 3 mm. high. These tend to slope gradually towards the growing edge and then dip down abruptly. One or more calicles appear in the angle formed at the bases of these mounds, sometimes on their distal faces. The surface cœnenchyma is covered with frosted granules which are the tips of the thick vertical elements of the thickening cœnenchyma.

There are two small fragments of this type which were previously labelled together *M. papillosa*, Lamarck, by Brüggemann; they have, however, none of the special features which are attributed to Lamarck's type.

The description given above is based chiefly upon the larger explanate fragment *a*, which shows a growing edge. Judging from the very small size of the calicles, and from their distance apart and consequent fewness compared with the mass of the cœnenchyma, the coral is probably a very slow growing one. The thick solid layer on the epitheca seems to indicate that the full growth is a large horizontal frond. The smaller fragment (*b*) is a portion of a frond at least 7 mm. thick. The stock from which it was broken was old and dead, and a small new growth has started from its surface and curled ventrally round the thick fractured edge of its predecessor.

It is clear that we know too little of either fragment to claim this as more than a provisional grouping. At the same time, the specimen *a* is quite large and normal enough to represent a new type.

It is worth noting that the section of the smaller fragment (i.e. of its dead and corroded portion) shows the fan-like arrangement of the threads of the thickening layer which indicates the gradual submergence of papillæ; cf. the same phenomenon in *M. ambigua*. This suggests that the papillæ of the adult stock of *b* were symmetrically nipple-shaped; if so the fragment should come near *M. verrucosa*. On the other hand, the calicles have greater resemblance to those of *M. Brueggemanni*, in being very minute, inconspicuous, and irregular.

a. Fiji Islands. F. M. Raynor, Esq. (Type.)
? b. „ „ „ „

55. **Montipora lanuginosa.** (Pl. XIII.; Pl. XXXII. fig. 20.)

Description. — Corallum explanate, thin, translucent, freely expanding or encrusting, creeping or drooping over former growths or other corals and calcareous algæ, the stocks thus forming great irregular mounds. By creeping up and enveloping Serpula tubes, or projections of the substratum, short irregularly bent branches are formed. There are thus smooth expanding portions alternating with irregular mounds of knobs and crooked lobate processes. These irregular areas may rise into almost spherical lobulated masses like the inflorescence of a cauliflower. Epitheca very irregularly developed.

Calicles crowded, less than their diameter apart. Full sized calicles in the thicker parts of the corallum from 0·5 to 0·75 mm., much smaller in the thinner explanate portions. The calicles have no sharply circumscribed margins, and are chiefly recognisable by the radial arrangement of the septa round a fossa. Held up against the light the stars are ragged and unsymmetrical. Six primaries are well developed, of which one, sometimes two, form directives; thin secondaries appear irregularly. On the under side the calicles are specially minute, opening on the smooth reticular surface; they are often very irregular in shape and in their septal apparatus.

Cœnenchyma purely reticular; when resting on an epitheca or encrusting a worm-tube it forms a perfectly solid layer in contact with them. At the surface the reticulum rises in the interstitial spaces into large loose papillæ, which, to the naked eye, have a woolly appearance, and under the pocket-lens are richly branching and have a ragged or flaming appearance. The calicles seem to open between the tangle of points at the bases of these papillæ, the septa being formed by the radiate arrangement of certain of the points themselves, hence the absence of any sharply circumscribed margin to the calicular aperture. In the thicker parts of the corallum, the papillæ are somewhat more compact and often run together, giving rise to small calicle-bearing nodules. On the thinner and more explanate portions, they are less pronounced and more irregularly and openly branched. The under surface is always smooth. The reticulum may be loose and thread-like near the margin, or solid and stony, with pores and fissures, at some distance from the growing edge.

There are two large specimens forming irregular mounds nearly 40 cm. across, and 15 to 20 cm. high in the highest parts. Each is composed of an irregular arrangement of thin expanding portions, generally sloping downwards and outwards, and great shapeless nodulated masses, with here and there thick, bent, finger-like processes, each encrusting the calcareous tube of an Annelid. The smooth explanate parts look like old flannel, the surface of which has been rolled into minute but loose knots. Both specimens are from Mauritius, and were previously labelled *M. tuberculosa*, Lamarck (cf. p. 112).

The two specimens present some striking differences. While both have smooth flannel-like portions, the nodulated portions of *a* are quite irregular and shapeless; but in *b*, the

greater part of the coral rises into almost spherical masses divided into lobes which are again further divided into smaller lobules, very much like the peculiar specialisation of *M. lobulata*. Indeed, I was inclined to unite them on account of the close similarity existing between this portion of specimen *b* and the whole corallum of that type (see below).

a, *b*. Mauritius. (Types.)

56. **Montipora flammans.** (Pl. XX., in the centre of *M. danæ*.)

Description.—Corallum a thin (3 to 4 mm.) encrusting sheet with free edge (2 mm. thick), supported by epitheca. Successive layers cover one another.

Calicles very minute. The pinhole-like calicular apertures appear to be rather less than 0·25 mm. in diameter, and average about 1 mm. apart. They are sharply circumscribed by the flakes of the reticulum which are cut out in the form of the aperture with its twelve septa. The six primaries (two directives well developed) are more pronounced than the secondaries.

The cœnenchyma consists of a flaky reticulum, which in part lies quite flat, having the appearance of a patchy white membrane in which the calicular apertures are sharply cut out. In the more vigorously growing portions, the reticulum rises up like branching flames from the interstitial spaces, giving a general appearance closely similar to that described for the explanate portions of *M. lanuginosa*.

I was in some doubt whether this should be separated from *M. lanuginosa*, which it somewhat resembles. Close examination of the calicles, however, made it necessary to describe them apart. Further, while the woolly surface is superficially alike in both, there is no tendency to form such pronounced papillæ in this type as in *M. lanuginosa*.

The single specimen in the collection has been grown over by the vigorous expanding growth of *Montipora danæ*. In the figure of that type (Pl. XX.) a small portion of *M. flammans* can be seen rising up in the centre and intertwining with the larger coral as if struggling for the mastery. The greater part of it is concealed under the latter. Examination of this hidden portion shows several previous growths, so that the stock was an old and important one before the larger coral settled upon it.

a. Port Darwin, Great Barrier Reef (with *M. danæ*). Coll. Saville-Kent. (Type.)

57. **Montipora lobulata.** (Pl. XIV.; Pl. XVI. fig. 1; Pl. XXXIII. fig. 1).

Description.—Corallum may form a compact convex mound of large rounded lobes, irregularly fused, but with deep cavities between, or a straggling, shapeless, lobate mass. The surface of the large rounded lobes is divided into secondary smaller lobes separated by smooth

shallow valleys. The corallum is built up by successive irregular encrustations, the creeping margin being 2–3 mm. thick, but increasing to 7 mm. at 1 cm. from the edge. An epitheca closely follows the growing edge.

The calicles are numerous, less than a diameter apart, deep, open, very conspicuous in the smooth valleys and depressions, but obscured on the lobes; about 0·75 mm., fairly sharply circumscribed; the septa irregularly and unevenly developed, sometimes small as in the crowded calicles in the valleys, sometimes, as on the higher portions of the lobes, star-like and symmetrical, with six well developed primaries reaching almost to the half radius circle, with rudimentry secondaries.

The cœnenchyma is a delicate filamentous reticulum, in which, in sections of explanate creeping edges, the middle streaming layer can be distinguished. A solid layer is frequently deposited on the epitheca. The bottoms of the valleys consist of smooth, open reticulum. On the lobes the cœnenchyma of the narrow interstices protrudes, swelling out above the surface as if squeezed out from between the calicles. These knob-like papillæ are of all sizes, with one, two, three or more calicles deeply sunk in their sides. These irregular rounded knobs spring up in groups, and the irregularity of the surface thus formed causes the lobed surface of the next growth, each lobe being again covered with these smaller papillate knobs. The calicles which develop on the papillate knobs first appear as minute indentations in their flat swollen tops.

There is one large specimen of this beautiful coral. Owing to the general similarity between the lobes of this specimen and the lobed portion of specimen *b* of *Montipora lanuginosa*, I thought at first that the two might be connected. But closer observation shows that they are quite distinct in almost every detail and that their resemblance is merely superficial. In *M. lanuginosa*, there is nothing like the curious knobbed and calicle-bearing papillæ looking as if they had been squeezed out from between the crowded calicles in the valleys.

a. Diego Garcia. G. C. Bourne, Esq. (Pl. XIV.) (Type.)

It is obvious that this method of papillate growth might easily give rise to branching specimens. I have therefore placed under this same heading a coral from Mauritius which I had arranged under *spumosa*, near which it seemed to come. It is, however, much nearer this type; the swollen knobs hardly differ from those of the type, excepting that they show a tendency to rise as short finger-shaped processes which grow out in all directions and fuse irregularly. The resulting stock is an irregular branching tuft of processes which is in great contrast with the compact, lobed mass of the type specimen. In this specimen, the calicles are not quite so crowded and on the average they are a little larger.

b. Mauritius. (Pl. XVI. fig. 1.)

58. **Montipora edwardsi.** (Pl. VIII. fig. 3; Pl. XXXIII. fig. 14.)

? *Montipora multilobata*, Milne-Edwards and Haime, Ann. d. Sci. Nat., xvi. (1851) p. 58.

Description.—Corallum consists of tufts of columns rising vertically from an irregular platform. The columns are thin and roughly circular at their bases (0·5 to 1·0 cm. thick), but thicken as they rise, having all the appearance of consisting of clusters of digitate processes grown together into compact bundles. The tops, 6 to 7 cm. high, are very papillate, swell out into irregular knobs which fuse with those of adjacent columns and form another irregular platform. When the lower platform is dead, the columns die down in regular stages, a white film separates the living from the dead; this film appears to go through the substance of the coral as a kind of tabulate plate, only the projecting edges of this plate curl up a little way like an epitheca; below the film, the cœnenchyma is quite bare and only differs from that above in being corroded. The films appear at intervals of from 1 to 3 cm.

Calicles star-shaped, vary greatly in size. On the smooth lower sides of the columns they are minute (0·5 mm.), shallow, and inconspicuous. On the papillate tops of the columns, where the cœnenchyma is growing rapidly, they are deep, conspicuous, and some 0·75 mm. in diameter. Primaries thick and well developed, the upper directives often very pronounced and exsert. A second cycle sometimes represented by a few well developed septa, but seldom complete.

Cœnenchyma. The axial streaming layer is reticular and is not very sharply marked off from the cortical layer which is also reticular. Thin trabecular threads may, however, be traced in it; these rise into jagged echinulæ at the surface. The swollen knobs at the tops of the columns appear to be due entirely to the rapid upward growth of the axial reticulum which shoots into tall, round and swollen papillæ which appear as if squeezed out from the narrow interstices between the calicles and rise 2 to 3 mm. high. Small level patches full of calicles are here and there surrounded by towering masses of these papillæ.

This papillate Montipore differs from all the rest in the fact that the papillæ are confined to the fused tops of the columns. This is doubtless due to the fact that as the columns rise and thicken, the hollows between the papillæ round their bases and sides fill up and the columns become smoother.

As in the last type, the papillæ are swollen as if forcibly squeezed out from the narrow interstices.

The single specimen was labelled *M. crista-galli* by Brüggemann, from the Red Sea. This is hardly in accordance with Dr. Klunzinger's redescription and photographs of Ehrenberg's types. I thought myself at first that it might be the *M. multilobata* of Milne-Edwards and Haime. I was, unfortunately, unable to find that type in the Paris Museum, but I saw there a very beautiful series labelled *crista-galli*, showing so many variations in growth that it is quite possible one of them was Milne-Edwards' *multilobata*, and this series appears to be closely related to the specimen in our National Collection.

The series referred to shows two extremes of growth. Small fan-shaped fronds, 3 to 4 mm. thick, rise upon thin stalks in close clusters and fuse indiscriminately, their expanded portions being twisted and bent in all directions; from the edges of the fans papillate processes rise, so that each looks not unlike a cockscomb. In the other extreme, the cluster is so compact that the fans are no more distinct, but merely their stalks rise like columns supporting a solid mass, the top of which rises into cœnenchymatous papillæ. One cause of this difference in growth appears to be the number of foreign organisms, sponges, &c., which keep the cluster loose and open. The specimen in the National Collection may, I think, be provisionally, regarded as another growth-form of this same coral, which, failing any evidence that it really is *M. multilobata*, I have called *M. edwardsi*; the chief difference to be noted being the character of the papillæ, which were large and round topped in the Paris specimen, but are here narrow and swollen as if squeezed up between the narrow interstices.

a. Red Sea. [Register No. 97. 9. 25. 2.] (Type.)

[Cf. the mode of growth of *M. alveopora*, described in the Appendix.]

59. **Montipora acanthella.** (Pl. XII. fig. 1; Pl. XXXIII. fig. 2.)

Description.—Corallum encrusting, with free drooping outgrowths, the edges of which curve upwards and, in bending, are crumpled into small irregular folds. The upper surface of the coral is thrown up into jagged processes of all sizes which may grow out in any direction. Repeated encrustations of such an uneven surface make the whole stock very irregular. The growing edges are 3 mm. thick and generally deeply pitted with numerous young calicles. The epitheca is very irregularly developed.

Calicles small, 0·50 to 0·75 mm., inconspicuous, evenly distributed, about 1 mm. apart. Septa variable, either six well developed primaries crossing the half radius circle with only faint traces of a second cycle, fossa inconspicuous, or else primaries short with secondaries distinct and fossa conspicuous. Stout directives are generally present. The calicles on the under surface are slightly smaller and closer together.

The streaming layer of the cœnenchyma is a dense and coarsely filamentous reticulum; the lower thickening layer is still more dense, while the upper layer rises irregularly into sharp ridges and papillæ. The larger papillate ridges throw out from their sides secondary ridges and papillæ also with sharp edges and points; hence the jagged outgrowths mentioned above. The under surface is smooth, and smooth pendent knobs covered with calicles may protrude from among the epithecal and other encrusting films which cover up most of the central region of the under surface.

There is only one specimen, some 24 cm. in long diameter; the stock is creeping over a dead and corroded previous growth. The coral is peculiar in the irregular distribution and shapes of the papillæ, and in the jagged processes which grow out of them by the secondary budding of young calicles from their surfaces, accompanied by secondary formation of sharp ridges or papillate points.

a. Locality not recorded. [Register No. 97. 5. 18. 7.] (Type.)

60. **Montipora fungiformis.** (Pl. XII. fig. 2; Pl. XXXIII. fig. 3.)

Description.—Corallum encrusting, with drooping, outwardly sloping edges which are free, without epitheca, very friable and thick, 6 to 8 mm. The heaped up centre is quite irregularly swollen into knobs of all sizes and shapes, often induced by large worm tubes. Fresh free edges often grow out of the knobs and elevations and closely cover, without immediately fusing with, the main stock.

Calicles very minute and densely crowded in the narrow valleys and depressions between the elevations. On the more favourable positions, the calicles reach nearly 1 mm., generally star-shaped, and from 1 to 0·5 mm. apart. The primaries are irregularly developed, with conspicuous directives, often laminate; secondaries only partially or not at all developed. Fossa deep and conspicuous. On the under surface, the calicles are small, crowded, and star-like.

Cœnenchyma consists of a thick laminate streaming layer which forms the often swollen, rounded and very friable edges; the elements bend upwards to form a reticulum which swells up into nipple-shaped papillæ. These are either separate and distinct, occupying the whole interstitial space, or they rise as side walls in relation to individual calicles, or they fuse together in small groups, frequently surrounding calicles with a rampart, or all may fuse over a small area, which is then foveolate, the calicles being at the bottom of deep pits.

The surface texture varies, being sometimes (i.e. in some specimens) very echinulate, so that the papillæ and surface look soft and hairy; in others this character is hardly recognisable.

There are four specimens. The type specimen (*a*) is a large oval mass, 30 cm. across, with drooping edges. A dead mass of coral underneath seems to have formed the original attachment and the stock is the result of several encrusting growths drooping over one another, each new growth reaching further than the last. This specimen is marked by a singular development of echinulæ. The smallest specimen (*b*) has been detached from *a*, on which it formed a short ridge due to worm tubes. From the ends of the ridge two drooping lobes of fresh growth hang down, smothering so much of the main stock but not fusing with it.

The specimens *c*, *d*, show the same general characters, but are not so markedly echinulate.

a. Locality not recorded.	[Register No. 97. 5. 18. 8.]	(Type.)
b. (Fragment of *a*) ditto	[„ 97. 5. 18. 2.]	
c, *d*. „ „	[„ 97. 5. 18. 3/6.]	

For another species, *M. saxea*, belonging to this group, see Appendix.

b. Papillæ in close relation to calicles as hoods, underlips, &c.

61. **Montipora bilaminata.** (Pl. XVI. fig. 2; Pl. XXXIII. fig. 4.)

Description.—Corallum expanding freely as a thin, translucent, slightly wavy, concave plate of even thickness, 2 mm. (1 mm. at edges), covered underneath by a hard, smooth, and shining epitheca.

Calicles almost completely hidden from view, the apertures being arranged in the angles at the bases of the papillæ and looking mostly towards the growing edge and only occasionally looking upwards, when the papillæ are not developed. Apertures from 0·5 to 0·75 mm. in diameter, star-like, with two cycles of granular septa, the second cycle less developed than the first.

Cœnenchyma, in section, shows the typical layer of outwardly streaming reticulum of variable thickness, but usually very thin and passing both above and below into dense, solid upper and lower layers of nearly equal thickness, and both of them thicker than the reticular layer. The cœnenchymatous papillæ form hoods over the calicular apertures. The greater part of the interstitial space itself is level, or even somewhat depressed. The hoods vary greatly in size, from mere elevations slightly tilting the aperture to conical or cylindrical processes, with rounded tops rising 2 mm. high and measuring 2 mm. at the base. The papillæ show a tendency to form irregular concentric rows parallel with the edge. In section, the papillæ are seen to be hollow elevations of the solid upper layer. In the interstitial spaces, the solid surface is beset with fine granules.

This is quite a unique type of Montiporan. The solidification of the upper thickening layer, the papillæ rising immediately behind the calicles and not occupying a more median position in the interstitial space and thus forming hoods of solid matter over the calicular apertures, are features which distinguish this type from all the others in the National Collection.

There are six specimens in all. Two are fragments which appear to have been parts of a (circular?) concave plate, the larger fragment being 13 cm. long by 8 deep; neither shows the method of attachment to the substratum. The growing edge of the larger specimen appears to have begun to die down, being covered by a film. This is also an unusual phenomenon, the centre being the region which as a rule first decays. This larger fragment shows very slight traces of any epitheca, the under surface being formed by the solid layer covered with small granules; only a portion of a wrinkled epitheca is visible. The smaller specimen is supported right to the edge by epitheca, which looks smooth and glassy to the naked eye, but is very finely striated concentrically.

a. Macclesfield Bank, China Seas, 32 fathoms.	Coll. Bassett-Smith. (Type.)
b. Apparently from the same place.	„ „

In addition to these there are two other specimens, one a large, rather crumpled fragment, apparently of a very old stock, which differs somewhat from the type. Upon the epitheca, which is wrinkled, rests a thick solid layer, often tunnelled through by other organisms; above this occurs the reticular layer. The upper thickening layer, though very dense, is not as solid as in the type. The whole corallum, too, is thicker and older, and the calicles are consequently deeper and more conspicuous as dark holes. Their close association with the papillæ which rise up over them as hoods is, in this case, visible to the naked eye.

These specimens are connected with *a* and *b* by the hood-like papillæ; they differ chiefly in the less complete solidification of the upper thickening layer. It is possible that this solidifica-

tion is physiologically correlated with the thinness of the horizontally growing corallum, and is not developed in thicker and older stocks or when not required.

c. Macclesfield Bank, China Seas, 25–30 fathoms.	Coll. Bassett-Smith.
d. Macclesfield Bank, China Seas.	H.M.S. 'Rambler.'

Two other specimens, which are perhaps varieties, also belong here. They are small, thin, nearly circular plates, very disfigured by Balanids, growing horizontally, one growth covering up another. Wherever the surface is free from encrusting calcareous algæ, tubicolous worms, or Balanids, it is a mass of warts of all sizes, many being smooth, round, dome-shaped. The larger and more irregular warts, on close inspection, are young Balanids very nearly or quite covered over and killed by the cœnenchyma. Hardly any calicles are visible when the coral is searched from above. Directly it is looked at sideways from the growing edge fairly conspicuous calicles, like those of the type, are seen on the faces of the dome-shaped papillæ.

e, f. Macclesfield Bank, China Seas, 28 fathoms.	Coll. Bassett-Smith.

62. **Montipora guppyi.** (Pl. XV.; Pl. XXXIII. fig. 5.)

Description.—Corallum explanate, as a large, nearly flat, expanding frond, with lateral edges irregularly reflexed, and attached by a thick narrow stalk. The growing edge is thin and sharp, under 2 mm., the stalk being about 1 cm. thick. An epitheca follows about 6 cm. behind the distal growing edge, and about 3 cm. from the lateral crumpled edges of the frond.

Calicles distinct, large and open, about 1 mm. diameter, irregularly crowded, mostly less than one diameter apart, hardly visible on the smooth surface close to the growing edge, but gradually, at 1 cm. from the edge, become hooded over by uprisings of the cœnenchyma, the aperture tilting but very slightly outwards. Six primaries well developed, reaching to the half-radius circle, secondaries slight, here and there; the interseptal loculi are sharply cut out of the flakes of the reticulum, and when secondaries are indicated, are heart-shaped. On the under surface, the calicles are very inconspicuous and are less crowded, about 0·5 mm. aperture, and open on the smooth but slightly pitted reticulum.

Cœnenchyma. The typical layers of the section are obscured, the whole being a coarse reticulum which becomes denser as it recedes from the thin, reticular growing edges. In surface texture it appears as if consisting (in the older portion of the colony) of glistening flakes and granules, the latter being jagged and twisted in all directions, throwing up fine points. The tendency to rise behind the calicles becomes more pronounced, the further one goes from the edge, till the whole surface is covered with papillæ, on the distal faces of which, low down near their bases, calicles open. The originally hood-like papillæ, by increasing in size, often carry up neighbouring calicles also which had no hoods, so that in the older parts

of the frond, knobs 4 to 5 mm. high and 4 to 5 mm. broad occur with six or seven calicles scattered about over their surfaces. Here and there a calicle may be seen opening on the tip of a papilla.

The cœnenchyma of the lateral reflexed surface is far more flaky than is that on the upper surface.

There is only one specimen of this papillate Montiporan. There was a suggestion on the original label that it is allied to *M. scabricula*, Dana; with this I cannot agree, the latter coral appears to belong to the tuberculate group while this is obviously papillate; besides, there is no similarity whatever in the manner of growth.

a. Treasury Island, Solomon Islands. Dr. Guppy. (Type.)

63. **Montipora tubifera.** (Pl. XVI. fig. 3; Pl. XXXIII. fig. 6).

Description.—Corallum a thin, freely expanding and bent plate which covers and arches over previous growths to which at its centre it is attached, 1 to 1·5 mm. thick, supported by epitheca to within 6 to 7 mm. of the edge.

Calicles conspicuous but minute, 0·3 to 0·5 mm. in diameter, scattered, opening either on the smooth surface of the coral, or at the ends of nariform hoods; with very irregular margins; six short, thick, granular and very irregular septa. Hardly any calicles on the under surface.

Cœnenchyma. The very loose, open-meshed streaming layer forms the great mass of the corallum; below, it deposits a thin, solid layer upon the epitheca, and above also it tends to form a nearly solid layer which is developed only in patches. In the level bottoms of the wavy corallum, the surface is a smooth reticulum of a much finer and closer texture than is that of the streaming layer; while on the upwardly sloping portions of the stock, viz. towards the growing edges, the surface rises in nariform excrescences of varying length, from mere hood-papillæ up to ridges 6 to 7 mm. long, gradually rising to a height of about 1 mm. They are often swollen a little at their tips and then descend abruptly; while the hood papillæ invariably cover calicles, the long nariform ridges only occasionally have calicles opening at their tips. They are only roughly parallel or rather radial. They wave about and at the growing edge itself may meet and fuse, rising then to a greater height.

This coral is closely allied to *M. bilaminata* from the same locality. But the calicles are smaller and the specialisation of the surface cœnenchyma is quite distinct, although there are slight indications of such nariform ridges on specimens of *bilaminata*. The name *tubifera* is suggested purely by the appearance presented by the nariform ridges, with calicles opening at the flattened tips. The calicles do not, of course, run down within the ridges but descend at a much more rapid slope towards the epitheca. Further, only a small proportion of the calicles open at the tips of the ridges, the greater number open on the face of the coral, or on

the faces of hood-papillæ, and mostly slightly tilted so as to look towards the growing edge.

a, *b*. Macclesfield Bank, 32 fathoms.	Coll. Bassett-Smith. (Type.)
c. (A distorted fragment) Macclesfield Bank, 28 fathoms.	Coll. Bassett-Smith.

Variety *a*.

Two fragments from the same locality, but found at a less depth, differ from the above in that all the calicles are so distinctly tilted towards the growing edge as to be covered by very short nariform upgrowths of the streaming layer; among these short, irregular, hood-like coverings, there occur long thin radial ridges which are only exceptionally nariform. The calicles are larger, but of the same general character as those of the type. On the under surface, calicles are rare, none appearing till about 3 cm. from the growing edge, when, there being no epitheca as in the type, a few seem to break through.

These two specimens were labelled *M. lima ?*, Lamarck, by Mr. Bassett-Smith, and it is true that the general method of growth is very similar to that of the foliate Montiporæ. Their more upright growth, their general appearance and absence of epitheca are in accord with this. The Lamarckian species is, however, I believe, the same as "*foliosa*," and it is better to keep these specimens, which are but small fragments a few cm. long, nearer to those from the same locality with which they are more obviously allied.

d, *e*. Macclesfield Bank, 26½ fathoms.	H.M.S. 'Rambler.'

64. Montipora crista-galli.

Porites crista-galli, Ehrenberg, Korallenthiere (1834) p. 116.
Non *Manopora crista-galli*, Dana, Zooph. (1848) p. 494, pl. xlvi. figs. 1, 1*a* (= *M. aspera*, Verrill).
Non *Montipora crista-galli*, Milne-Edwards and Haime (= *M. abrotanoides*), Cor., iii. (1860) p. 211.
Montipora crista-galli, Klunzinger, Korallenthiere, ii. (1879) p. 34, pl. vi. fig. 1; pl. v. fig. 6; pl. x. fig. 5.

Description.—Corallum a branching tuft, the closely crowded branches and twigs often fusing together so as to form broad flat erect leaf-like plates with their upper edges toothed and lobed. At the sides of the plates ridges may run down a short way.

Calicles from 1 to 0·5 mm. in diameter, regularly distributed about 1 diameter apart. Aperture very irregular, the interseptal loculi opening freely to the meshes of the surface cœnenchyma. More than six septa, of which one or two directives are often conspicuous. No calicles appear along the growing crests and tips of the branches and twigs.

The cœnenchyma appears at the surface as a very irregularly porous reticulum rising to form projecting lower margins to the calicles; these projections are concave and hardly ever form a wall right round the whole calicle. These projections make the coral look very rough.

The above diagnosis is based upon Dr. Klunzinger's re-description and photographs

of Ehrenberg's type specimen, which is 10 cm. high and 15 cm. broad. The description makes it clear that the cœnenchymatous elevations are, as in the case of *M. gracilis*, simply the swollen under margins of the calicles. Proliferations of these under lips may give rise to small cylindrical twigs covered with calicles. Klunzinger remarks that this type is very similar to Ehrenberg's *circumvallata* (also from the Red Sea). In view of the very similar specialisations of the cœnenchyma, I think it highly probable that the two are really specifically identical.

The specimens in the National Collection which agree closest with this description are two from the Persian Gulf. One specimen shows the cockscomb-like upgrowths springing at right angles from a lateral expansion of an encrusting plate. On to this encrusting mass the other specimen, which forms a thick, roughly speaking globular tuft of fused branches, exactly fits. The two specimens thus really belong to one and the same stock.

The stock, studied as a whole, forms an irregular platform across the tips of other branched corals, the corroded remains of which can still be seen. From this platform the coral rises in tufts, each tuft apparently starting as a long, narrow ridge. One such tuft (specimen *b*) 10 cm. high and 10 in diameter, rises from a narrow ridge-like base 3 cm. long and varying from 1 to 0·5 cm. broad; while a little way off another such ridge is beginning to rise as a thin cockscomb, the sides and edge of which are commencing to put out twigs. The developed tuft (*b*) is a compact mass of flat ridged plates, and thin fringe-like twigs often fused side by side. At a height of 6 cm. a deposit of sediment seems to have caused the tuft to form another partial platform.

The specialisation of the cœnenchyma is that of the type. On the thin, cylindrical twigs, however, the calicles are so crowded that the protuberant lower margin of one forms the upper margin of that next below, so that to all appearance the calicles are walled around (cf. *M. circumvallata* which is said to differ from *crista-galli* in the very fact that the calicles are walled round). We see here that this distinction is of very little value, the variation depending entirely upon the distribution of the calicles.

On the fine series of Montipores in the Paris Museum, identified with Ehrenberg's type, see *Montipora Edwardsi*, p. 78.

a, *b*. (Fitting together to form one stock) A. S. G. Jayakar, Esq.
Persian Gulf.

65. Montipora gracilis.

Montipora gracilis, Klunzinger, Korallenthiere des Rothen Meeres, ii. (1879) p. 37, pl. vi. fig. 7; pl. v. fig. 12; pl. x. fig. 9.

Description.—Corallum small, stunted, forming irregularly branching tufts, the ultimate twigs being not unlike protuberant calicles, the whole having some resemblance to a typical Madrepore. The basal portion dies away and is covered by a white film, above which the living zone is about 4 cm. deep.

Calicles minute (0·5 mm.) but distinct; evenly distributed about 1 mm. apart. Septa in two cycles, very irregularly developed as short thick granules projecting from the surface

cœnenchyma over the margin of the aperture, which may also be a solid ring from which the septa project.

Cœnenchyma. The axis of the coral is occupied by a reticulum of stout threads, open in the newer branches but dense in the basal portions of the stock. The thickening cortical layer is characterised by a general tendency of the threads to radiate outwards, but it is not sharply marked off from the axial layer. The reticular threads end at the surface in granules, small jagged plates, or echinulæ. The interstitial spaces are as a rule smooth, but the lower edges of the calicles show a tendency to protrude. These protrusions may remain slight or may develop so greatly that a fresh bud appears on their under surfaces, so that the minute calicle-like twigs mentioned above are produced. Further buddings at the sides of these twigs give rise to branches which, if calicles appear at their tips, look very like the twigs of Madrepores.

The small specimen of this coral in the Museum is from Dr. Klunzinger's collection and is a tuft 6 cm. high rising from a single narrow stalk about 1 cm. thick. On the reefs, these tufts fuse together. Dr. Klunzinger's figure (pl. vi. fig. 7) shows one with two stems, and the branches are much more massive and compactly fused together.

Dr. Klunzinger says that the specimen is very near Ehrenberg's *crista-galli* and Dana's *nudiceps* (= *abrotanoides*). As, however, the original figure of this latter shows it with tall cylindrical papillæ, I do not think that the affinity can be very close. The type seems to stand alone as a very natural variation in method of growth. Many Montipores put out the lower margins of the calicles; the development of these into branches seems to be the chief characteristic of this species.

On the label, in Dr. Klunzinger's handwriting, the locality is given "Koseir," but in his description he says it occurs on the steep edge of the reef in the surf at Safaga, two days journey from Koseir. The colour is said to be a brown yellow.

a. Koseir (? Safaga). Dr. Klunzinger.

66. Montipora spongiosa.

Porites spongiosa, Ehr., Korallenthiere (1834) p. 115.
Montipora spongiosa, Klunzinger, Korallenthiere, ii. (1879) p. 38, pl. vi. fig. 3; pl. v. fig. 10; pl. x. fig. 10.

Description.—Corallum grows in compact tufts of more or less upright, irregularly swollen, knobbed and thickly branching stems; the tips are finger-shaped, slightly angular, and often, through fusion, somewhat flattened; the stems are fused below to form irregular plates. The stocks grow 18 cm. high, the end branches being 1 to 4 cm. long, 1 to 0·5 cm. thick, when not flattened.

Calicles very conspicuous and deep, 1 mm. in diameter, somewhat scattered, generally more than a diameter apart. Septa irregularly and feebly developed, portions of two cycles. Margin irregular.

Cœnenchyma finely but loosely porous and rising up very slightly in the interstitial

spaces, confined as a rule to a slight protrusion of the lower margin of the calicle (*cf. M. gracilis*). The surface is a delicate reticulum, web-like with small echinulations; the branches are very light and brittle.

The colour is yellowish.

This is the description given by Dr. Klunzinger of one of Ehrenberg's types in the Berlin Museum recognised by the former as a Montipore. Dr. Klunzinger suggests its affinity with the *M. multilobata* of Milne-Edwards and Haime.

This is one of the many tufted forms from the Red Sea, cf. *gracilis, crista-galli, circumvallata.*

67. **Montipora circumvallata.**

Porites circumvallata, Ehrenberg, Korallenthiere (1834) p. 115.
Manopora circumvallata, Dana, Zooph. (1848) p. 496.
Montipora monasteriata, Klunzinger (*non* Forskål), Korallenthiere, pt. ii. (1879) p. 34, taf. vi. fig. 2; v. fig. 9.

Description.—Corallum a tuft of branches tending to expand above, yet all reaching to about the same height. Below, they tend to fuse into leaf-like plates, even the free branches are not round but slightly flattened and angular; they end bluntly. The lower portions of the stock die away.

Calicles crowded, conspicuous, with six septa, sometimes more. Cœnenchyma moderately porous. The papillate uprisings tend to form protruding under-lips to the calicles. Towards the tips of the branches these are more numerous, and individual calicles may be surrounded, but in that case, the individual papillæ composing the rampart are usually recognisable. The papillæ, which make the whole appear very rough, are 1 to 2 mm. in breadth and height.

This is the substance of Dr. Klunzinger's redescription of Ehrenberg's type. It agrees well with the photographs. On Ehrenberg's suggested identification of it with Forskål's *monasteriata*, a suggestion adopted by Klunzinger, see p. 137.

Dr. Klunzinger's photographs show that this type is much more distinctly papillate than either *M. crista-galli* or *M. gracilis.* The papillæ appear to fill up the whole of the interstitial spaces and not merely, as in these forms, to project as under-lips to the calicles.

68. **Montipora stalagmites.**

Montipora stalagmites, Ortmann, Zool. Jahrb., iii. (Syst.) (1888) p. 154, pl. vi. fig. 2.

Description.—Corallum mounts up from an explanate, encrusting, but not extensive base into a fused mass of upright processes which may be either thin and cylindrical, often hardly 5 mm. thick, or broader and leaf-like; these fuse together, their tips give off blunt or slightly pointed branches which often coalesce and then again break up into thin cylindrical branchlets. The branches often attain a height of 15 cm.

The calicles are small (0·5 mm.), crowded, slightly protuberant as short cylinders, with one cycle of septa.

Cœnenchyma spongy, towards the tips of the branches slightly and irregularly echinulate, below perfectly smooth.

The above description is from the original. The type is certainly peculiar in the presence of what appear to be regular cylindrical protuberant calicles. On this account Ortmann, who at that time (1888) followed Dana, placed it with that author's *Manopora gemmulata*, as one of the transition forms, with degenerating calicles, between *Madrepora* and *Manopora*. He was apparently not aware of the transference of *M. gemmulata* to the genus *Turbinaria*. The protuberant calicles perhaps imply a very thin upper layer of cœnenchyma, and may be either a return to, or a retention of primitive conditions.

The type specimen, which is in the Strasburg Museum, was from Tahiti.

c. Papillæ arranged in radial series and fusing to form ridges.

69. Montipora papillosa.

Agaricia papillosa, Lamarck, Anim. sans Vert., ii. (1816) p. 243.
Montipora papillosa, de Blainville, Manuel (1834) p. 389, pl. xi. fig. 2.
Manopora papillosa, Dana, Zoophytes (1848) p. 506.
Montipora papillosa, Milne-Edwards and Haime, Ann. des Sci. Nat., (3) xvi. (1851) p. 56; and Cor., iii. (1860) p. 216, pl. E 3, figs. 2*a*, 2*b*, 2*c*.
Non *Montipora papillosa*, Bassett-Smith, Ann. and Mag. Nat. Hist., (6) vi. (1890) p. 450 (see *M. ænigmatica*).

Description.—Corallum explanate, horizontal, with slightly raised free edges. Epitheca about 3 cm. from edge, less in younger fronds. The growing edge is from 2 to 3 mm., the central portions of the corallum as much as 5 mm. thick.

The calicles are conspicuous and crowded in the older parts of the corallum with the apertures slightly depressed beneath the level of the interstices, but for 3 to 4 cm. from the growing edge the calicles open more superficially; they appear smaller on this account and less crowded and conspicuous, 0·75 mm. in diameter. Twelve short, thick, and symmetrically arranged septa, the primaries being distinguishable from the secondaries, one or two directives occasionally present.

On the under surface, the calicles open through small protuberant rings, very irregular and slightly raised, very uniform in size, about 0·5 mm., and with but feeble development of septa.

The cœnenchyma shows in section a very pronounced, coarse and laminate reticulum which in the free edges of the corallum bends evenly upwards and downwards. When the epitheca commences, the tips of the lower threads or laminæ fuse to form a solid layer; while dorsally the reticulum surges above the surface in cylindrical or oval papillæ. Near the growing edge, these tend to slope slightly outwards; their tips, however, often bend up into the vertical,

or even slightly backwards. Where the corallum begins to thicken, i.e. above the edge of the epitheca, the reticulum surging up not only slightly submerges the calicles but even the papillæ, till only their bent up tips are left above the surface. Thus on the older parts of the stock the papillæ are not so conspicuous as they are on the outermost zone (3 to 4 cm. deep) of the growing edge. The papillæ rise to about 2 mm. in height, and are from 1 to 1·5 mm. thick; they often fuse into short ridges which are obviously composed of two to three traceable papillæ, and which run either longitudinally or transversely or quite irregularly. The appearance of the surface is very woolly, the coarse open reticulum lying immediately below the surface, and forming the core of the papillæ, terminates in a thick crop of fine echinulæ, blunted or even slightly granular at their tips but of uniform height, so as to give almost a velvety aspect to the surface.

This description is based upon the Museum specimens, and there is very little doubt but that this is the *Montipora* (*"Agaricia"*) *papillosa* of Lamarck. The figures of this type given by de Blainville and by Milne-Edwards, appear both intended to represent the type specimen in the Paris Museum, No. 255*a*, although they differ slightly. In de Blainville's figure the arrangement of the papillæ in radial ridges is very pronounced, the papillæ being long ovals, and morever the ridges taper away to fine points at the growing edge. This latter is not the case in Milne-Edwards' figure, but the ridges are long and thick, although on the enlargements they are shown to be obviously formed of fused, more rounded papillæ. Examination of the original specimen shows that it comes about half-way between the two figures.

In the Museum specimens the papillæ (except where they first rise out of the reticulum with a gradual slope) are almost uniformly round or cylindrical, and not the long oval as figured by de Blainville and Milne-Edwards, and they are not at all so crowded as in the specimens figured by these authors. Again, the serial arrangement is only conspicuous in young fronds or near the growing edges. In the older parts of the coral the papillæ are scattered, many having been apparently submerged.

Counterbalancing these differences, however, we have the laminate streaming layer, the woolly appearance of the papillæ, and the surging up of the bottoms of the valleys, and on the under surface the protuberant calicles, the irregular droppings of the cœnenchyma, and the appearance of the laminæ of the streaming layer as parallel striæ for a short distance round the margin, as features in common; and these, it seems to me, quite outweigh the slight differences in the exact order and shapes of the papillæ.

The type specimen in the Paris Museum is said to be from Tongatabu, whereas the British Museum specimens are all from Torres Strait.

a–d. (Fragments of a large frond), Torres Strait.	Prof. A. C. Haddon.
e. (Young fronds), Torres Strait.	„ „

70. **Montipora denticulata.** (Pl. XVII. fig. 1.)

Description.—Corallum explanate, more or less circular, flat or convex, growing out freely and horizontally from some lateral attachment, at least 10 cm. deep; thin, 2 to 2·5 mm. thick at the edge, margin toothed or notched, each tooth corresponding with a longitudinal

row of papillæ. A wrinkled epitheca closely supporting the edge, occasionally rolled back by a reflection of the latter.

Calicles conspicuous as deep, round, open holes (1 mm. in diameter) sunk in the surface. Septa thus first appear below the surface, in two cycles, thin, the primaries projecting far into the fossa, but irregularly so as nearly to fill the cavity. Calicles more or less in rows, i.e. in the valleys between the radial series of papillæ.

The cœnenchyma is purely reticular. The streaming layer is a thin thread reticulum with open meshes, which dips very slightly down, forming here and there a solid layer on the epitheca, but bends sharply up to form the thickening layer without any marked change in its character. At the surface it rises into bluntly conical papillæ. The bases of these papillæ form no sharp angle with the surface, but slope gradually away. These papillæ rise from low ridges which are later submerged by the thickening layer. Near the growing edge the ridges are alone visible, each ridge corresponding with a projection of the denticulate margin. The valleys between the ridges are, as a rule, narrower than the aperture of the calicle. The papillæ seem to be formed by a fan-like arrangement of the reticular elements. The surface is a very open, fluffy or hairy looking reticulum.

This species differs from all others in the presence of the teeth round the margin and in the regularity of the radial ridges. The papillæ are round and conical and not long-oval, and the calicles are like large round holes and very conspicuous. Of the five specimens, two are quite typical; unfortunately they are only fragments, showing, however, portions of the edge and depths of 4 and 7 cm. The only complete specimen has been distorted, and the papillæ over a large part of the surface are quite irregular in size, shape and arrangement. Its upper surface has begun to die down near the place of attachment. It measures some 10 cm. deep.

In addition to these there are two more fragments which were originally tied together as if they had been fragments of the same stock. Though these differ somewhat from the type in having very inconspicuous calicles, there can be no doubt that they are specifically identical, and the difference is to be explained as due to the accident of growth. They are very thin and seem to be almost entirely composed of the streaming reticular layer. The small size of the calicles is due to the absence of the thickening layer. There is thus no trace of the deep submergence below the surface which makes the calicles into the conspicuous black holes of the type specimen. On one fragment, however, the cœnenchyma appears to be rising and the process of submerging the calicles is beginning, and this links the two on to the type specimens *a* and *b*.

a, b. Macclesfield Bank, China Seas, 25–30 fathoms.	Coll. Bassett-Smith.	93. 9. 1. 88. 97. 9. 25. 1.	(Types.)
c. Macclesfield Bank, China Seas, 22–30 fathoms.	„ „	93. 9. 1. 80.	
d, e. Macclesfield Bank, China Seas, 25–30 fathoms.	„ „	93 9. 1. 84.	

71. **Montipora pulcherrima.** (Pl. XVII. fig. 2; Pl. XXXIII. fig. 7.)

Montipora prolifera,* Bassett-Smith (*non* Brüggemann), Ann. and Mag. Nat. Hist., (6) vi. (1890) p. 450.

Description.—Corallum explanate, slightly scallop-shaped. Living zone about 10 cm., growing edge very thin, 1 mm. Thickest part from 3 to 4 mm. An epitheca from 2 to 4 cm. from growing edge. Numerous pendent knobs on the under surface (5 to 6 mm. in diameter) are slowly grown over by the epitheca.

Calicles minute, 0·25 mm., and scattered, in all the thinner parts (i.e. for some 5 cm. from the edge) raised as small irregular cylinders or hoods above the surface. Six primaries, thick, granular and irregular, reach to about the half radius circle, secondaries only here and there incompletely developed.

On the under surface the calicles are mostly raised on slight eminences, which may develop into the pendent knobs by the secondary proliferation of the reticulum. Calicles appear on the sides of the knobs.

The cœnenchyma shows in section the typical streaming reticulum, resting upon a dense layer deposited upon the epitheca; the layer forming the upper surface is sharply differentiated from the underlying streaming layer by being granular and nodulated and rather compact. This dense reticulum rises up abruptly into tall flat plates of nearly uniform thickness, generally arranged longitudinally in the line of growth, sometimes flowing together to form tall coarsely toothed ridges. These plates and ridges reach a height of 2·5 mm., and are less than 1 mm. thick. They are often slightly wavy and may even bend over sideways. Here and there on the coral these ridges or series of plates and papillæ may be so close together and regular as to remind one of the jagged septa of a Fungia. A section across one of these papillæ reveals the dense reticulum immediately under the surface, which itself is finely granular and almost smooth to the naked eye. In the troughs between the ridges the calicles appear on small cup or cylinder-like prominences. On the under surface the cœnenchyma has a solid appearance, but the proliferation of the reticulum which gives rise to the pendent knobs is a very loose, open filamentous sponge-work.

There are four specimens, the largest in three fragments which fit together to form a scallop-shaped stock about 10 cm. deep by 10 broad. The specimens were labelled *M. prolifera* by Bassett-Smith, owing to the resemblance between the ridges on the young fronds of that type and on this specimen. There is, however, no proof that these ridges, which are more pronounced and regular than on the young fronds of *prolifera*, ever develop as they do in that type. Again, the youngest specimen of this coral is very different from the youngest frond of *prolifera*. It is a beautifully rich pink and yellow peach colour, the ridging is very irregular

* Printed by mistake "*M. prolifica*, Brüggemann MS.?"

and crowded, and between the ridges are numbers of cylindrical calicles squeezed in between them. The deep vertical ridges in this type may help to strengthen the thin corallum.

a. (In three pieces) Macclesfield Bank, 20 fathoms.	H.M.S. 'Rambler.'	(Type.)
b, *c*. (Young specimens), 13 fathoms.	„	„
d. (Young specimen), 20 fathoms.	„	„

Another specimen, apparently a fragment of a very large frond, from the same locality, showing the same development of tall thin plates of uniform thickness and forming parts of longitudinal series, with the same general method of growth and very nearly the same texture of the cœnenchyma, must also, on these counts, be classed here. This specimen was also labelled *M. prolifera* by Mr. Bassett-Smith. The remarkable differences may, perhaps, be referred to the age and thickness of the frond. The ridges tend to be broken up into tall thin papillæ, slightly swollen and twisted at their tips; the corallum, exclusive of the papillæ, is nearly 5 mm. thick as against about 2·5 mm. in specimen *a*; the tendency to raise the calicles above the surface is only just traceable, while the calicles themselves are much larger, being nearly 1 mm. across. They are also deep and conspicuous and with primaries reaching across the half radius circle (one septum often specially developed as a directive), and six minute and irregular secondaries. I place this specimen with the rest because it is possible that the development of the upper thickening layer would bring about these changes, the calicles would grow, and the lower continuous portions of the longitudinal ridges be submerged. The surface between the papillæ is everywhere concavely depressed and smooth, being composed of a flaky reticulum, the flakes lying mostly in the horizontal plane. There are no pendent knobs on the under surface.

e. Macclesfield Bank, 26½ fathoms.	H.M.S. 'Rambler.'

A distorted encrusting fragment, with no definite character on the upper surface, but with indications of papillæ such as are shown on the last specimen, may belong here. This and the next are remarkable for the great depths at which they appear to live.

f. Macclesfield Bank, China Seas, 27–40 fathoms.	Coll. Bassett-Smith.

Another specimen, disfigured by Balanids, but apparently belonging here.

g. Macclesfield Bank, 30–44 fathoms.	Coll. Bassett-Smith.

The last specimen, while it apparently belongs here, is remarkable because it appears to be a transition form between this type and the tuberculate species, *M. minuta*. It differs from the type chiefly in the tendency to produce tubercles round the growing edge; the ridges are like those of the type, but a little way from the edge the whole surface between the ridges becomes tuberculate. The ridges are much lower and more continuous, tending, however, to break up into series of tubercles. The tubercles themselves are usually very small, seldom rising as high as the ridges. Here and there the ridges may be mere papillæ; while these

latter are of all sizes, so that it is often not easy to say whether a given excrescence is a tubercle or a papilla.

The streaming layer forms the greater part of the section. A solid layer is deposited upon the epitheca, but the typical knob-like protrusions of the reticulum break through this solid layer. The epitheca grows over them, but one or two calicles may remain open on their most distal surfaces. The tubercles seem to have hardly any trabecular roots, as above the streaming layer the reticulum is very thin. Hence the difficulty of ascertaining whether a given excrescence is a tubercle, that is, a thickening of a single thread of the reticulum, or a papillate upheaval of a mass of the reticulum itself. The calicles are hardly visible except with a lens, being hidden among the low tubercles. The specimen was labelled *M. lima* and tied up with specimen *d*. The specimens of *M. minuta* with which it appears to be allied were also labelled *M. lima*.

h. Macclesfield Bank, China Seas, 20 fathoms. H.M.S. 'Rambler.'

72. Montipora prolifera. (Pl. XVIII.)

Montipora prolifera, Brügg., Journ. Mus. Godeffroy, xiv. (1879) p. 209.
Montipora lima, Id. ibid. (*non* Lamarck).
Non *Montipora prolifica* (= *prolifera*), Bassett-Smith, Ann. and Mag. Nat. Hist., vi. (1890) p. 450 (see *M. pulcherrima*).

Description.—Corallum consists of large (usually distorted) fronds which bend upwards as they freely expand. The more horizontal fronds have the epitheca stretching almost to the growing margin. On the more sloping fronds the epitheca is from 3 to 4 cm. distant from the margin. Edge 2 mm. thick in the more sloping fronds. In older stocks the corallum is thickened by successive encrustations over the surface of the more horizontal fronds.

The calicles are star-like and very numerous, here and there being less than their diameter apart, often arranged conspicuously in radial rows between the ridges. They vary in size according to the thickness of the surrounding cœnenchyma. On young fronds they are inconspicuous and between 0·3 and 0·25 mm. in diameter; in older and thicker portions of the same stock they are 0·5 mm. Twelve well developed septa, the secondaries being slightly smaller than the primaries. The fossa is open and deep. On the under surface the calicles are very unevenly distributed; a few excessively minute apertures are found near the margin opening on the level surface of the dense cœnenchyma, while further away others, larger, 0·25 to 0·3 mm., open on papillæ.

The cœnenchyma shows in section the streaming reticulum on the one hand, depositing a thick dense layer on the epitheca, while on the other it rises up into the papillæ and ridges of the upper surface. The surface shows great variations, according to the slope and age of the frond. In young fronds and larger upwardly sloping first growths the papillæ (which may be quite small and indistinguishable from tubercles), fuse to form ridges, which may or may not run together to form long radial keels. Such ridges, when formed, may be regularly

toothed except near the growing edge, where they are swollen, irregular, numerous, and joined together in every conceivable way. On older stocks, or under conditions which appear unfavourable for rapid upward extension of the margin, the ridge system develops to an extraordinary extent, the ridges themselves rising higher, meeting and fusing at all angles, the calicles being at the bottom of angular pits, 5 to 6 mm. deep. The whole surface then becomes irregular and throws up pointed, angular and ridged processes swelling into branched knobs 5 to 6 cm. high.

There are four specimens of this coral, all from Ponape; two, which appear to be taken from one and the same stock, were labelled by Brüggemann *M. prolifera*, in reference to the extraordinarily rich development of the cœnenchyma. The other two are much more simple and were labelled *M. lima*, Lamarck. In spite of their striking superficial differences they cannot be separated. The forms labelled "*prolifera*" owe the rich development of their surface cœnenchyma to the peculiarities of their growth, and in large measure to the fronds being old and re-encrusted with fresh cœnenchyma. Not only are the young fronds on these portions of an old stock like the specimens named *M. lima*, but on one of the specimens of "*prolifera*" the surface of the old dead frond is visible upon which the new and rich layer of cœnenchyma has developed, and it presents the simpler features of the young fronds of the same specimens and of the fronds labelled "*Lima*." I have no doubt, therefore, that these belong together.

Brüggemann adds that his species *prolifera* comes somewhere between *M. exesa*, Verrill (from Gaspar Straits), and *M. lichenoides*, Verrill, but he hardly felt confident enough to point out the differences. These two species have here been included, together with *M. lima*, in the synonymy of *M. foliosa*, and the question arises as to whether this type should not also be included in the same list. The simple leaves (specimen *b*) indeed show very little difference from those of *M. foliosa*. In section, however, there appears to be a considerable difference. Whereas, in *foliosa*, the trabeculæ are usually distinct and rise up into tubercles which, however, may become secondarily indistinct when fused to form ridges, in *M. prolifera* true tubercles are not usual; the papillæ, large and small, are composed of an uprising of fine reticulum. It is worth noting, however, that there is a possibility of this extraordinary richness of surface formation being the result of distortion, inasmuch as the young fronds are thin and appear to curve symmetrically upwards like those of *foliosa*, but the fronds here described as typical are crumpled, nearly horizontal, and grow one over the other. The fusion of papillæ, formed as they are out of reticulum and not out of rigid trabeculæ, perhaps accounts for the rich development of the surface cœnenchyma.

This type therefore is retained for two specimens showing a richness of surface development surpassing that of all other Montipores known to me. At the same time it must be expressly understood that the more normally expanding fronds show great resemblance to the fronds of *M. foliosa*. Further, small crumpled fronds of *M. foliosa* develop a surface cœnenchyma resembling that of *M. prolifera* but on a comparatively insignificant scale.

Hence this type stands really alone as a very specialised development of the foliose *Montiporæ*, the ridges and tubercules of *M. foliosa* having here passed into very pronounced papillate ridges.

a–d. Island Ponape. (Types.)
e–g. Island Ponape (interesting fragments).

In addition there are two unbleached fragments from the edges of fronds, the longitudinal ridges of which are very tall and thick. The colour of the thin growing edge is bright red-brown, which gradually changes into deep olive-green. This colour, however, tends to whiten along the tips of the ridges.

h, i. Amboyna. Vienna Museum.

73. **Montipora australiensis.** (Pl. XVII. fig. 3; Pl. XXXIII. fig. 8.)

Description.—Corallum consists of several concentrically arranged, nearly horizontal folia, not standing as separate cones but growing out laterally from some point of attachment, the whole cluster appearing as a semicircular mass. The edges (which are 2 mm. thick) are slightly lobed, the lobes being bulged downward. Each leaf seems to be deeply wrinkled concentrically at intervals, as if the edge periodically drooped and then turned up again; from the crest of these wrinkles, knobs and small finger-like processes may spring up. Epitheca only developed beneath the dying inner edge of the living zone of each leaf.

Calicles distinct, star-like, numerous, slightly less than 1 mm. in diameter, six well developed series of septal spines, slightly swollen at their tips, rudimentary secondaries sometimes partly represented. Single calicles often raised 1 to 2 mm. above the surfaces on the papillæ. On the under surface, the calicles are almost as numerous as on the upper surface, regular, and at some distance from the edge slightly prominent, with two cycles of septa; the primaries thickened and slightly exsert. On smooth portions of the cœnenchyma they may be very minute and crowded, as is the case also on the upper surface.

Cœnenchyma shows, in section, a laminated streaming layer, which comes to the surface at the growing edge. For a varying distance from the edge the upper surface is smooth, the streaming layer merely mounting to form the distal walls of young calicles, which are thus nariform (Pl. XXXIII. fig. 8). Here and there, round the growing edge, the upper edges of the component laminæ are visible as white radiating striæ on a pink ground (cf. *M. papillosa*, *M. striata*). The thickening layers, upper and lower, are more densely reticular. The lower one gradually becomes almost solid and nearly 3 mm. thick, pierced however by calicles. The upper is of very varying density. Here and there, but not typically, solid trabeculæ appear. These rise above the surface either as short single tubercles or else in groups round a calicle, which they lift above the surface (cf. *M. striata*). The reticulum more commonly forms ridge-like papillæ swollen or pointed at the tips, and forming angles and curves which partially surround calicles. The calicle is very often raised by the papilla, into the side of which, however, it is sunk. Where these papillæ have formed groups raising the cœnenchyma into definite mounds and finger-like processes, the cœnenchyma between such mounds may be a smooth open reticulum with great numbers of star-like calicles opening on its surface without any protecting cœnenchymatous elevations.

On the under surface the solid cœnenchyma forms a mosaic of plates separated by deep fissures (cf. *M. striata*).

There are eight specimens of this coral, the most important being a fine large semicircular stock (Pl. XVII. fig. 3) consisting of four large leaves, the lowest of which is over 20 cm. deep. In addition to this there are two single detached folia and five fragments, especially beautiful because they have preserved what appears to be the original rich coloration of the coral in nature.

The large stock appears to have grown outwards (and slightly upwards) from the side of some object. The leaves die down at the centre, and the zone of life is not more than 6 to 9 cm. deep along the edges, this zone covering both surfaces. The dead portions of the coral are covered by an enormous number of large worm-tubes and molluscs of such a size as to suggest that the coral grows very slowly. This impression is also increased by the number of large Balanids buried in the cœnenchyma of the living zone. The general aspect of the upper surface is rough, owing to the innumerable angular papillæ and papillate processes.

The tendency of the cœnenchymatous elevations to rise up in finger-shaped processes, in the sides of which calicles are sunk, combined with the fact that some of the leaves are more thickly covered with such processes than others, suggests that under the accidents of growth this coral might have quite a different shape. The form which is possibly nearest to it is one from the same locality, viz. *M. striata*, the striated border of this latter type occurring here also. No epitheca is developed in either: in texture the under surfaces are very much alike. The two, however, differ too greatly, especially in the fact that *M. striata* is purely tuberculate, to be classed together without a longer series of connecting specimens.

A further interesting feature is the similarity of the cœnenchymatous specialisation of this type with that of *M. prolifera*. Though the result is almost the same, the principle of formation differs entirely. This species raises the calicles on pointed papillæ. In *M. prolifera* the processes rise from a fusion of the radial ridges.

The two detached leaves (*b* and *c*) are interesting as showing how the roughness and irregularity of the surface is acquired with the growth of the stock. One, which is the fragment of a large leaf, shows marked concentric wrinkles with the risings of the cœnenchyma along the ridges of these wrinkles; the other, which is a young complete folium, is almost smooth, thin and translucent, the concentric wrinkling being only faintly indicated.

The edges and under surfaces of these specimens are suffused with orange-yellow, which is very bright round the calicular apertures. The under surface of the oldest leaf, however, is a pale olive-green, but from the fragments *d* to *h*, which are richly coloured, we learn that these larger specimens have been partly bleached. The original (?) colours are in every shade from a deep olive-green to a yellowish olive-green, passing into a rich orange, which again passes into a rose-pink.

a. (Old stock) Houtman's Abrolhos, West Australia.	Coll. Saville-Kent.		95. 10. 9. 58. (Type.)
b. (Fragment of old leaf) Houtman's Abrolhos, West Australia.	„	„	95. 10. 9. 54.
c. (Young leaf) Houtman's Abrolhos, West Australia.	„	„	95. 10. 9. 53.
d–h. Houtman's Abrolhos, West Australia.	„	„	95. 10. 9. 45.

74. Montipora patinæformis.

Madrepora patinæformis, Esper, Forts., i. (1797) p. 94, pls. 75 and 76.
Non *Montipora patinæformis*, Studer, MB. Akad. Wiss. Berlin (1878) p. 538.

Description.—Corallum expanding, large, apparently whole or half disc-shaped, highest in the centre, and with slightly drooping edges like a shallow inverted bowl; the edges are very slightly lobate, and the surface of the coral shows what appear to be the outlines of former lobed edges of previous growth periods. Towards the centre the stock is about 12 mm. thick, at the edge 3 mm. On the under side the epitheca extends to within 5 to 6 cm. from the edge, which appears radially wrinkled.

The calicles on the upper side crowded and arranged in curved rows between the ridges, six-rayed; on the under side sparse, very minute, either level with the surface or raised on slight wart-like eminences which are covered over by the epitheca.

The cœnenchyma appears in section to be purely reticular. The reticulum rises into highly echinulate ridges which twist about irregularly between the calicles. On the under side the cœnenchyma is solid and granular.

This description has been put together with some difficulty from Esper's text and figures. He called the specimen the cup-shaped star coral, but assumed, in his description, that the "latus interius" was the upper side, the epitheca being a crust of Millepora. To add to the confusion, in his explanation of the figures (p. 94), he names the sides correctly, the upper side being the latus exterius (of the cup), and the under side being the latus interius.

There is no reason to doubt the general accuracy of the figures. In these the most striking feature is the running together of the interstitial eminences into labyrinthine curves. This, then, must be taken as the special feature of this coral; cf. *M. undata*, and more especially *M. viridis*. Further, the highly echinulate ridges call to mind the singularly hairy papillæ of some specimens of *M. fungiformis* (Pl. XII. fig. 2), the method of growth of which might easily give rise to the stock described by Esper. On the other hand, there are only doubtful traces on *M. fungiformis* of labyrinthine series of papillæ.

There is, therefore, no specimen in the National Collection showing the characters of Esper's type, nor indeed any Montiporan at all from Tranquebar, where the specimen described by Esper was found.

The colour is described as being, towards the surface, a reddish-grey, somewhat lighter in the interior of the corallum.

Milne-Edwards and Haime merely mention this type, and follow Dana in suggesting that it belongs to the foliose group of Montipores. Studer, in 1878, probably following this suggestion, described a large stock formed of conically rolled fronds (from Salvatti, Galevo Straits) as agreeing with Esper's description, and in 1888 Ortmann * thought Esper's type might be the same as Brüggemann's "*prolifera*." These identifications seem to me quite inconsistent with Esper's detailed description. The form of the corallum, with its drooping fungiform margin, removes it far from the foliose group, all of which consist of more or less erect spirally curled leaves, and without any trace of labyrinthine ridges.

* Zool. Jahrb., iii. (Syst.) p. 156.

75. **Montipora undata.** (Pl. XXI. fig. 2; Pl. XXXIII. fig. 9.)

Description.—Corallum thin, encrusting, the free edges 2·5 to 4·0 mm. thick, at first drooping, but ultimately bending outwards into the horizontal plane; unsupported by any epitheca.

Calicles conspicuous, 0·75 mm. in diameter, the margin not sharply circumscribed, rather close to one another in single or double rows in the serpentine valleys between the cœnenchymatous ridges. For some 2 cm. round the free horizontal edge the calicles are invisible from above, being few in number and pointing outwards from the faces of the cœnenchymatous uprisings. Septal apparatus well developed and symmetrical, the primaries reaching to the half radius circle, the secondaries being about half the size and thickness. When the apertures are not sharply bounded, the primaries stand up somewhat above the cœnenchymatous reticulum. Individual calicles may rise straight up from the bases of the valleys as thin uniform cylinders 2 mm. in diameter, reaching as high as 5 mm. On the under surface calicles are numerous, and each is surrounded by a delicate cœnenchymatous ring.

The cœnenchyma is a beautiful, very regular, filamentous reticulum with hardly any differentiation into layers. The streaming layer is, however, just recognisable as such. Round the edges this foams up into radiating ridges which meet irregularly or rise into crests. In the central portions of the corallum the ridges are twisted and bent, enclosing serpentine valleys; here and there they rise into crested knobs or eminences. The floors of the valleys on the more level surfaces seem to be formed of a more open and rapidly growing reticulum than that forming the ridges, which appear as if they were being submerged. The ends of the threads form fine echinulæ over the whole surface. The reticulum of the under surface is also light and open, and only becomes more solid in the older and decaying portions. It may remain smooth or the interstices may hang down either in large cylindrical knobs, or each interstice may bulge down like a gathering drop.

This coral recalls *M. prolifera*, but the cœnenchymatous elevations are quite different; they are comparatively thick and open, while in *prolifera* they may be very thin, and so crowded and irregular that the calicles in the deep dark holes and valleys between them can hardly be seen; the texture of the cœnenchyma is also different. In this last point the type resembles *M. spumosa* in being an open filamentous reticulum with an echinulate surface. A fragment of a knob, if detached, might easily be classed with *M. foveolata*, or rather with *M. socialis*, because the cœnenchymatous ridges form ramparts with a few calicles in the valleys between them, very similar to those in this last named type.

The serpentine ridges of a central part of the corallum and its drooping edges class it with the last type, *M. patinæformis*. On the other hand, the valleys are much wider and the ridges round the edge are markedly radial. There is, further, no trace of any epitheca, and the under surface is not wrinkled or stony but a light porous reticulum.

The tall cylindrical calicles are very peculiar, and suggest at first sight the presence of commensal worms, but though small worm-tubes do here and there raise up the cœnenchyma, these cylinders contain true calicles.

a. Moluccas. Purchased. (Type.)

76. Montipora viridis. (Pl. XXXIII. fig. 10.)

Description.—Corallum forms irregular loose clumps of thin angular branches, often compressed, with very uneven surfaces, pointing in almost any direction and fusing freely.

Calicles conspicuous, 0·5 to 0·75 mm. diameter, with distinct margin, primaries thick, well developed, regular, reaching to near the half radius circle. The two directives frequently conspicuous, secondaries irregularly developed. Calicles frequently rise up in contact with the ridges, which often encircle their apertures. Calicles also appear at the tips of the branches.

In sections of the branches a loose open reticulum, laminate but porous, is conspicuous. This carries on the tips of the branches. The radial or cortical reticular layer soon becomes almost solid and glassy, but is traversed by the conspicuous polyp cavities and by a few pore canals. Round the tips of the branches the light axial reticulum rises into tall thin ridges of nearly uniform thickness and different lengths; these do not run strictly longitudinally, but are more serpentine and cut one another at right angles. They appear primarily as ramparts round the young calicles which open in the axial reticulum, and are of a light feathery texture. As the branches thicken and the solid cortical layer appears, these ridges also solidify and sink, as if partially submerged in the thickening surface layer. They then appear as low rounded serpentine ridges, ornamented along their edges by a regular system of transverse gashes; the teeth thus caused are frosted white against the deep glass-green of the solid ridge. In this condition they may twist round calicles as regular circular ramparts, the aperture with a distinct margin either remaining in the base or rising to the level of the rampart.

This unique and beautiful coral from Solomon Islands agrees with the Montipores from the New Guinea region, in the olive-green colour and the delicate beauty of its surface texture. There is no other known Montipore (except *M. patinæformis*, Esper, and *M. undata*), showing the peculiar serpentine ridging (cf. also *M. bifrontalis*, p. 165). In *M. effusa* the ridges are bent at all angles, but are much more crowded, and there is nothing like the serpentine arrangement seen in these beautiful specimens.

a. Solomon Islands. Vienna Museum. (Type.)
b. „ „ „
c. Two fragments. „

d. Papillæ regularly nipple-shaped or columnar.

77. Montipora planiuscula.

Montipora planiuscula, Dana, Zoophytes (1848) p. 507, pl. xlvii. figs. 3, 3*a*.

Description.—Corallum encrusting, glomerate, smooth surface, nearly 8 mm. thick.

Cells large, deep, sunk, indistinctly 12-rayed.

Cœnenchyma swells up in the interstitial spaces into marked convexities, which

are 2 to 3 mm. across, the whole space swelling about 1 mm. high. In section the tissue can be seen expanding fan-like under these interstitial eminences.

There is no specimen in the collection corresponding with this type. Milne-Edwards and Haime considered it identical with Lamarck's *M. verrucosa*, but it is obviously very distinct from the specimens which are here thought to represent the latter species, unless, being a fragment merely, it did not show the typical development.

Fiji Islands.

78. **Montipora mæandrina.** (Pl. XIX. fig. 1.)

Porites mæandrina, Ehrenberg, Corallenthiere (1834) p. 118.
Montipora monasteriata, Milne-Edwards and Haime (*non* Forskål), Ann. d. Sci. Nat., xvi. (1851) p. 57.
Montipora rus, Milne-Edwards and Haime (*non* Forskål), op. cit., p. 58.
Montipora rus, Klunzinger (*non* Forskål), Corallenthiere, ii. (1879) p. 36, pl. v. fig. 5, pl. vi. fig. 9, pl. x. fig. 8.

Description.—Corallum encrusting, rising into irregularly lobed, almost branching masses, fused together. Round the bases of the taller lobate portions the living coral occurs only in patches encrusting the dead previous growths. The creeping edge from 4 to 5 mm. thick, and, wherever freely projecting, supported by an epitheca.

Calicles conspicuous everywhere, even on the growing edge, deeply sunk between the strongly convex interstices; somewhat less than 1 mm. in diameter. Septa very irregular. The six primaries may be well developed, giving the aperture a distinct stellate appearance, the secondaries often not recognisable in the jagged and irregular margins of the interseptal loculi. At times the whole border of the calicle is so jagged and irregular that no clear septal arrangement is apparent.

Cœnenchyma is composed in section of a very solid reticulum, its thick threads not arranged as trabeculæ, they end at the surface as coarse granules or echinulæ, and account for the irregularity of the calicular margins. The interstitial cœnenchyma swells up into smooth rounded papillæ of all sizes, averaging from 2 to 3 mm. high, and from 2 to 5 mm. broad. These fill up the interstices in such a way as to leave a connected system of level valleys just wide enough to take the calicles. Round the growing edge where the cœnenchyma of the interstices swells up as if it would submerge the calicles, the interstitial papillæ occasionally fuse together to form ridges, and even thick, irregular knobs, lobes or branches. The tops of the lobes and branches are, however, often smooth and deeply punctured with calicles. Papillæ also occur in the deep narrow valleys between the lobes.

The two specimens in the collection obtained by the Museum at an interval of nearly thirty years can, curiously enough, be fitted together and then form part of what was evidently an old stock (Pl. XIX. fig. 1). The dead and corroded lower portions show traces of three earlier

growths. Two very fine stocks of the same coral, also from the Red Sea, are still in the collection of *Montipores* in the Paris Museum (261*d* and *e*), and are labelled *M. verrucosa*.

Klunzinger's photographs (pl. vi. fig. 9; v. fig. 5), show that his *M. rus* (not Forskål's) belongs to the same type. In calling it *M. rus* he follows (as Milne-Edwards and Haime did before him) Ehrenberg's queried suggestion that his *Porites mœandrina* might be Forskål's *M. rus*. It seems to me, however, impossible to reconcile the account given above with that of Forskål. The latter * speaks of raised denticulate undulating keels, and again says that between the higher keels the whole space appears filled with papillæ, and again, that in the higher and lower parts of the corallum the surface is delicately "papillosa-spongiosa," looking at a distance as if covered with a spider's web. Now, in the first place, the round knob-like papillæ on this type cannot be called keels, and in the second, Forskål's description applies best to those tuberculate *Montipores* which form their ridges by the flowing together of longitudinal series of tubercles.

For the differences between this type and *M. verrucosa*, see figs. 1 and 2, Pl. XIX.

We are indebted to Klunzinger for figuring Ehrenberg's specimens of his *Porites mœandrina*, which now becomes an established Montiporan type; the name apparently applies to the system of valleys between the papillæ. Comparison of the figures and descriptions will show that it is not far removed from *M. danæ*, but the papillæ, though larger than the interstitial spaces, are not so enormously developed as in that type.

a. Red Sea.	From Paris Museum. 49. 9. 28. 9.
b. ?	Coll. Bowerbank. 77. 5. 21. 203.

(These are two fragments of the same block and fit together.)

79. **Montipora danæ**. (Pl. XX.)

Manopora tuberculosa, Dana (non *Porites tuberculosa*, Lamarck), Zoophytes (1848) p. 506, pl. xlvii. fig. 2.

Montipora danæ, Milne-Edwards and Haime, Ann. d. Sci. Nat. (3°) Zool., xvi. (1851) p. 65.

Description.—Corallum explanate, horizontal, encrusting, sending up a few solid lobate processes from the surface. Margin thick, 0·5 cm., free, or creeping and encrusting; when free, the cœnenchyma streams back over the epitheca as flat encrusting layers or as thick pendent rootlets.

Calicles small, 0·6 mm., distinct, irregularly scattered on the smooth portions of the cœnenchyma, i.e. in the level valleys between the papillæ, rather far apart (ca. 3 mm.), except when arranged in rows close under the protection of the papillæ. Seen from above, star-shaped; seen slantingly, as round irregular holes; immersed, the marginal septa below the level of the cœnenchyma. Traces of two cycles of septa, but both cycles irregular in size and seldom symmetrically radiate; secondaries very feebly developed; the polyp cavities deep.

The cœnenchyma in the valleys between the papillæ is a loose, open and delicately

* Descrip. Animal., 1775, p. 135.

anastomosing reticulum which swells everywhere above the level of the apertures of the calicles. At irregular distances the cœnenchyma rises up into great rounded or thick flattened papillæ, very much larger than the interstitial spaces, averaging 5 mm. in height and 4 in thickness. The tops of these papillæ are always smooth and round. They may flow together to form complicated cœnenchymatous excrescences nearly 1 cm. high. The papillæ are entirely free from calicles; where, however, several flow together and raise the level of the corallum, calicles may appear in the angles between them. This flowing together tends to form the lobate prominences on the corallum, on the sides of which calicles appear.

There is a large and very beautiful specimen of this coral from Port Denison. It is a wavy horizontal growth, 32 cm. across in longest diameter, with edges mostly free but here and there encrusting. A part of it is intertwined with another encrusting Montiporan (*M. flammans*, p. 76). The papillæ are entirely confined to the upper surface; the under surface is a smooth reticulum of varying density, thickly strewn with inconspicuous calicles opening level with the surface of the cœnenchyma, and more symmetrical in the development and radiation of the septa than those on the upper surface. These calicles even appear on the pendent rootlets and downward streamings of the cœnenchyma. In the wider valleys between the papillæ the interstitial spaces are, as a rule, markedly convex, reminding one of Dana's type "*planiuscula*."

An objection to identifying this with Dana's *Manopora tuberculosa* from Fiji might perhaps be seen in the fact that the latter was massive and encrusting and not explanate. One specimen indeed was said to be 3 inches by 4 surface measurement, and 2 to 3 inches thick, i.e. clearly a massive growth. But the same difficulty occurs in other cases, e.g. in *M. verrucosa*, (see next page); what is said there applies equally well here.

Dana has a coloured figure of a contracted polyp of a bluish colour on a brick-red ground.

a. Port Denison. Coll. Saville-Kent.

There is also a smaller specimen of a bright yellow colour, with smaller and more regular papillæ, which, if not specifically identical with the above, is certainly allied to it. It shows nearly all the same features, even the pendent rootlets with calicles on the under surface. It differs, however, in the interpapillar surfaces being concave instead of convex, and in the apparent tendency of the calicles to open on the sides of the papillæ, though rather low down.

b. Macclesfield Bank, China Seas, 13–32 fathoms. Lords of the Admiralty.

80. **Montipora verrucosa.** (Pl. XIX. fig. 2.)

Porites verrucosa, Lamarck, Animaux sans Vert., ii. (1816) p. 271.
Non *Montipora verrucosa*, de Blainville, Dict. d. Sci. Nat., lx. (1830) p. 355 (= *M. obtusata*, Quelch).
Non *Montipora verrucosa*, Quoy and Gaimard, Voy. d. l'Astrolabe, Zool., iv. (1833) p. 247 (= *M. foveolata*, Dana).
Manopora verrucosa, Dana, Zooph. (1848) p. 506.
? *Manopora capitata*, Id. op. cit., p. 504.
? *Montipora verrucosa*, Milne-Edwards and Haime, Ann. Sci. Nat. (3°) Zool., xvi. (1851) p. 55.
Non *Montipora verrucosa*, Klunzinger, Korallenthiere, 1879, pt. ii. p. 35; pl. v. figs. 14, 15; pl. vi. fig. 10; pl. x. fig. 7 (= *M. venosa*).
Montipora verrucosa, Quelch, Challenger Report, Reef Corals (1886) p. 176.
Montipora capitata, Quelch, ibid.

Description.—Corallum may be either thick, explanate and encrusting or massive, the thick but narrow free edge being supported by an epitheca. The former method of growth, by the continued encrusting of previous irregular growths, may result in the formation of clumps of irregular, stout, branching processes; or again, by the edge creeping under the growing mass, free rounded coralla are formed without definite points of attachment, and completely covered by the coral. In the massive method of growth the corallum thickens by the steady growth of the cœnenchyma in the more central regions of the colony.

Calicles numerous, conspicuous as open holes, large (ca. 1·0 mm.), deeply immersed, except near the growing edges or on surfaces which have grown in unfavourable positions, in these cases the calicles are smaller and open on the smooth surface of the cœnenchyma. Two and sometimes three cycles of short thick septa, more or less equally developed, projecting but a very little way into the polyp cavity, and leaving a large open fossa in the depths of which the septa fuse to form an irregular columella. Adjoining calicles are sometimes separated from one another by a single thin perforated plate. Tabulæ may be formed in the lengthening calicles of massive growths.

The cœnenchyma shows the usual streaming layer, which bends upwards towards the surface, attaining in the massive forms a great thickness (6 to 7 cm.). This reticulum is slightly echinulate at the surface. The interstices usually swell up into nearly symmetrical nipple-shaped papillæ from 2 to 3 mm. high and 2 mm. thick. These papillæ exactly fill up an interstice, their walls descending directly into the polyp cavities. They are variously developed, sometimes crowded, and irregularly swollen and fused. As the corallum thickens in the massive forms the polyp cavities fill up with a very loose open tissue (columella formation) which is in marked contrast to that of the solid reticulum, which streams so directly upwards as here and there almost to suggest the presence of trabeculæ.

There are eleven specimens which are here combined together in spite of the differences in the method of growth. The characters which unite them are the symmetrical nipples

formed of undifferentiated reticulum, each filling up an interstitial area, and the open conspicuous immersed calicles. It should be noted that the confusion over this species has been great. De Blainville, who had access to Lamarck's types, figures as Lamarck's *verrucosa* a specimen which Milne-Edwards, who also had access to Lamarck's types, could not recognise, but which turns out to be the *Montipora obtusata* of Quelch. Lastly, the specimen on which the genus was founded by Quoy and Gaimard, and identified by them with Lamarck's *verrucosa*, had flat, tooth-like projections, and not the regular nipples of this species. Milne-Edwards and Haime, therefore, with much hesitation, renamed Quoy and Gaimard's specimen *M. Quoyi*; it is, however, here identified with Dana's *M. foveolata*, see p. 54.

There is, however, a specimen from Tongatabu in the Paris Museum (261*g*) which answers completely to the description of Lamarck's original type. It is an oval encrusting plate, 18 cm. by 12, and shows three successive growths. Among the other corals with which it is associated in the Paris Collection are two which very clearly belong to it, one being a small massive growth. There can be no doubt that these three are of the same species as the encrusting and massive forms in the British Museum Collection, grouped together under this heading by Brüggemann and Quelch. The chief difference between the flat encrusting and the massive forms is perhaps due to the different methods of growth. It lies in the fact that the calicles on the massive forms are more crowded; hence there are fewer of the convex interstices mentioned by Lamarck, and more conspicuous on the type specimen than in any of the encrusting forms in the British Collection.

A much more difficult question arises, as to the connection between certain coarsely branching specimens and the massive or encrusting specimens of *M. verrucosa*. In the National Collection the transitions can be easily traced, and branching specimens which Quelch identified with Dana's *M. capitata* (Sandwich Islands) are really only irregular growths of *M. verrucosa*. There are in the Paris Museum two large specimens (258*a*, 258*b*) from the Red Sea, strongly resembling these branching *M. verrucosa*, and I at first thought these might be the *M. capitata* of Dana. A closer comparison of the specimens with Dana's figure showed, however, that this could hardly be the case. Nor were they specimens of *M. verrucosa*, as here diagnosed; they appear to me to belong to an undescribed species. In the meantime the undoubted existence of branching specimens of *M. verrucosa* seems to me to justify the provisional association with this species of Dana's *M. capitata*.

Encrusting.—A specimen showing four layers, three of which are dead and corroded, the last one forms a cap with its edges drooping down all round; the edges are without papillæ and 4 to 5 mm. thick. Calicles unevenly distributed, very crowded and deep in parts without papillæ. The higher portion of the stock shows a tendency to rise up into knobs, and on these the papillæ are larger. One of these knobs has grown out into a process which leads to an irregular branching, as shown on specimens *b* and *c*. This encrusting specimen differs from Lamarck's type in the fact that the streaming layer is not so distinctly lamellate.

a. Honolulu. H.M.S. 'Challenger.' 86. 12. 9. 264.

Branching.—Two clumps of irregular knobs or branches, and on this account separated from *a* by Quelch and labelled *M. capitata*, Dana, whereas they appear to be only branched specimens of *a*. In this connection it should be noted that in Dana's figure of *M. capitata*, the calicles are indicated as small dots in wide level valleys, reminding one more of the conditions seen in *M. danæ* than of those which obtain in *M. verrucosa*.

b, *c*. Honolulu. H.M.S. 'Challenger.'

Massive, calicles and papillæ crowded, so that the whole surface is formed of tall nipples separated by deep holes, thin reticular walls separating the deep calicles from one another.

d, e, f. Tongatabu. J. J. Lister, Esq.

Massive, papillæ scattered, calicles about 1 mm. apart.

g. Great Barrier Reef. Coll. Saville-Kent. 92. 12. 1. 557.

A massive specimen in which the edges creep round in close contact with the former growths, tending to result in a globular mass. While some four edges can be counted, in the centre of the stock the cœnenchyma seems to have mounted continuously upwards without break.

h. Palm Island, Great Barrier Reef. Coll. Saville-Kent. 92. 12. 1. 281.

Two almost completely globular specimens, without apparent points of attachment, and apparently free and rolled about on the tips of the papillæ; *i* is only 5 cm. in longest diameter.

i. Fiji Islands. F. M. Rayner, Esq.
j. Torres Straits. Prof. A. C. Haddon.

In addition to the above there is a fragment of an undulating explanate growth, 3 to 4 mm. thick, and showing all the typical characters; the calicles are 2 mm. apart, and vary greatly in size, owing to the appearance of young calicles among the large old ones. This is a common phenomenon in this species, but not expected in an explanate growth. The papillæ are irregularly distributed round the edges, tending to fuse in short ridges. Epitheca 2 to 3 cm. from growing edge; numerous small calicles on the under surface tend to be slightly protuberant as thin, sharp-edged craters.*

k. Albany Passage, Great Barrier Reef. Coll. Saville-Kent. 92. 12. 1. 284.

There are two more specimens showing essentially the same nipple-shaped elevations of the interstitial reticulum. They differ, however, in various ways from the type, and are here classed as varieties.

Montipora verrucosa, variety *a*.

Description.—Corallum a large rounded mass, somewhat flattened but humpy at the top. The sides creep down and under the previous growth, tending to form a globular mass; very little free edge.

The calicles are conspicuous but are more equally distributed than in the type, averaging about their diameter apart. They are much smaller, 0·75 mm. in diameter. The septa are

* Mr. W. Saville-Kent has given, in his 'Great Barrier Reef' (chrom. plate viii. figs. 10, 10*a*, 10*b*), a coloured representation of an explanate Montiporan with scattered papillæ. The corallum is a vivid green, the twelve bulbous tentacles of the polyp are purple. His identification of this coral with *Montipora verrucosa* appears to be in accord with the conclusions here arrived at.

much more distinct as six stout, well defined rods reaching to the half radius circle, one or two directives being visible to the naked eye (secondaries hardly traceable). On the edge which creeps under the mass (for about 1 to 2 cm. from the growing edge, and until the papillæ appear), the calicles may have all the typical characteristics of those which usually develop on the under surfaces of Montipores, each being surrounded by a solid ring of cœnenchyma flush with the surface.

The cœnenchyma is a rather coarse, flaky reticulum which swells up convexly between the calicles, and here and there rises into the typical nipple-shaped papillæ. These papillæ occur in patches, and here and there isolated examples rise as high as those on the type, but as a rule they are much smaller, about 1 mm. high and 1 thick.

The single specimen appears to have led a free life, but to have incorporated other corals which it must have encrusted and then broken off (e.g. a stock of Mussa). It agrees with the type in essentials, but differs in the characters of its calicles and in the smaller size of its papillæ.

a. Palm Island, Great Barrier Reef. Coll. Saville-Kent. 92. 12. 1. 259.

Montipora verrucosa, variety *β*.

Description.—Corallum explanate, thick, 6 to 10 mm. at edge, 10 to 12 mm. 7 cm. from the edge. Under surface for 6 to 7 cm. from the edge free of epitheca, wrinkled, the wrinkles developing from the edge inwards, into deep valleys, the elevations between which become pendent and almost club-shaped knobs thickly covered with calicles.

Calicles on upper surface densely crowded, of all sizes from 1 mm. to minute specks, conspicuous, open. Two cycles of septa distinct and well developed; of the primaries one directive is very prominent and slightly exsert; fossa deep. On the under surface calicles slightly smaller, each surrounded by a complete ring often sharply protuberant and echinulate. The rings get thicker and more massive as they recede from the growing edge. Two cycles of septa more feebly and irregularly developed than on the upper surface, with only occasional indications of a directive septum.

Cœnenchyma in section shows a thick lamellate streaming layer, the leaf-like ends of which expand to form both upper and lower surfaces of the growing edge. The upper thickening layer is not much thicker than the lower. The upper reticulum appears almost trabecular, but near the edges both the upper and lower surfaces consist of a beautiful, open and delicate filamentous reticulum. Further off this becomes more dense and echinulate. In patches of the upper surface the interstitial spaces rise up into small nipple-like papillæ, 1 mm. high by 1 mm. thick at base, the sides of which slope straight down into the polyp cavities as in the type. The nipples are fragile and echinulate, and occur only in parts where the cœnenchymatous reticulum is somewhat more dense and flaky.

There is only one specimen of this coral. It is a fragment 7 cm. deep by 13 cm. long, broken from the edge of some larger explanate growth. It is quite unique in the collection, and ought perhaps to be classed separately on account of the small sizes of the papillæ, the exsert directives and the general texture of the cœnenchyma.

a. Thursday Island, Great Barrier Reef. Coll. Saville-Kent. 92. 12. 1. 287.

Montipora verrucosa, variety γ.

A massive specimen, 0·5 cm. at the creeping edge, 3 cm. thick in the centre; encrusting dead coral. The papillæ are typical but smaller, 1·5 mm. high, 1 mm. thick, and more scattered. The small calicles are densely crowded, less than one diameter apart except when papillæ fill up the interstitial spaces. The septa well developed; two cycles of septa. Two primaries (directives), sometimes three, very thick and prominent, being visible to the naked eye as short white lines reaching almost to the centre of the calicle, sometimes as very exsert plates.

As in the case of the last specimen, I was inclined to class this also separately. But the cœnenchymatous specialisation being essentially the same as in *M. verrucosa*, I prefer to class it as a variety rather than multiply species based on single specimens.

a. Great Barrier Reef. Coll. Saville-Kent. 92. 12. 1. 543.

81. **Montipora ambigua**. (Pl. XXI. fig. 1; Pl. XXXIII. fig. 12.)

Description.—Corallum explanate, edges slightly raised, 0·5 cm. thick at edge, 1 cm. in older portions, and still further thickened to 2 cm. by the irregular extrusion of calicle-bearing cœnenchyma through the dead under surface. A feebly developed epitheca apparently curled over and forced back by a layer of cœnenchyma growing backwards from the edge.

Calicles are conspicuous as black dots 0·5 mm. in diameter, aperture sunk in slight depressions of the surface reticulum. Two cycles of short thick septa irregularly developed. Where the corallum is thickening very rapidly, even submerging the papillæ, the apertures may be surrounded by distinct continuous cœnenchymatous rings. Elsewhere the interseptal loculi are not distinguishable from the irregular meshes of the reticulum. On the under surface the calicles are of all sizes, from specks invisible to the naked eye to round open calicles 0·75 mm. in diameter. The larger calicles are generally surrounded by a close ring of dots, which stand slightly above the surface and appear distinct from the surrounding reticulum.

Cœnenchyma in section shows a laminate streaming layer of irregular thickness, and well developed layers bending both upwards and downwards. The vertical elements of both these form almost typical trabeculæ. The reticulum of the upper layer rises into tall, round-topped, generally cylindrical papillæ, which rise sharply out of the surface reticulum and differ from it in texture, appearing smooth and woolly, or echinulate under the pocket-lens. This differ-

ence of texture is very marked where the open spongy reticulum is growing rapidly and submerging the papillæ. In sections the submerged papillæ can be distinguished from the rest of the reticulum by the fan-like arrangement of their elements. The papillæ reach their full height (2–2·5 mm. high to 1·5 mm. thick) about 1 cm. from the growing edge. Nearer the growing edge they diminish in height and seem to sink into the slight radial ridges which mark the border, while proximally to this zone they are progressively submerged by the thickening layer, persisting only in raised patches. There are no papillæ on the under surface, which is a smooth reticulum finely echinulate at its creeping edges.

This papillate coral stands quite alone in the collection. It differs from *M. papillosa* in its larger and more regularly cylindrical papillæ, in this respect approaching *M. verrucosa*. It differs from this latter, however, in the apparent independence of the papillæ of the calicle; they are sometimes larger and sometimes smaller, and seldom exactly fill an interstitial space.

The true character of the under surface is not easy to make out. There appears to be no epitheca following the free expanding edges; but the naked under surface appears to die down and then becomes grown over again both from the edge, and from scattered centres which perhaps resist the deleterious influence which has destroyed the greater part of the under surface.

a. Thursday Island. Coll. Saville-Kent.

32. **Montipora mammifera.** (Pl. XXXIII. fig. 13.)

Description.—Corallum small, horizontal, encrusting, thin, under 1 mm. thick at the growing edge, about 2 mm. in the thicker parts.

Calicles very minute, 0·25 mm., irregularly distributed, averaging about 1 mm. apart, conspicuously star-like. One, two, three or more primaries are generally distinct and even exsert; the secondaries are, when present, little more than granulations or echinulæ at the margin of the aperture; fossa conspicuous.

Cœnenchyma a comparatively speaking coarse reticulum which streams outwards towards the growing edge. In the older parts this forms a thick solid layer on the epitheca, while dorsally the layer also becomes very compact, the vertical threads being thick and trabeculate. On the surface these end as fine echinulations which, seen from above, appear powdery or granular, but seen sideways show as true echinulæ. Papillæ are of all sizes, and under the pocket glass highly echinulate, rising up over all the older parts of the corallum, from quite minute bushy surgings up of the reticulum to symmetrical nipple-shaped processes 1 mm. high by 1 mm. in diameter.

There are two small specimens closely encrusting lumps of coral débris. This, in the case of the smaller specimen, seems to be largely composed of a solid mass of Porites, with a regular trabecular structure and appearing at first sight as if it might belong to the Montipore. The reticulum of this latter, however, nowhere shows the regular trabecular character of the underlying mass; nor, on the other hand, do the regularly parallel trabeculæ of the *Porites*

show any trace of having formed nipple-shaped papillæ at its different levels. For it is often possible in thick papillate forms to trace the buried papillæ quite clearly in the arrangement of the reticulum (cf. *M. ambigua*). Specimen *a* is a slightly larger and more obviously encrusting specimen, with slightly coarser reticulum, thicker septa and more conspicuous calicles; the echinulæ are also more pronounced. Free edges appear, supported by an epitheca. Young calicles develop in rows on the outermost faces of the growing edge.

Although both these specimens are very small, they appear to be growing perfectly normally and to be practically complete stocks. They thus claim to constitute a separate type, there being no other such small encrusting papillate Montipores.

a, *b*. Bird Island, Seychelles (7 fathoms, sand and coral). H.M.S. 'Alert.' (Types.)

83. **Montipora sinensis.** (Pl. XIX. fig. 3; Pl. XXXIII. fig. 11.)

Description.—Corallum thick, encrusting, with free edges 5 mm. thick and rapidly thickening to 1·5 cm. A well developed, wrinkled epitheca to within 1 cm. or less of the edge.

Calicles inconspicuous, delicately star-shaped, 0·75 mm., sunk somewhat below the surface of the cœnenchyma as indentations, the floors of which are formed by the close star-like arrangements of the septa. Two cycles of long septal teeth, the primaries crossing the half radius circle, two often more pronounced as directives. To the naked eye the septa seem to fill up the cavity so that no dark fossa is visible. On the free under surface the calicles are very minute, 0·5 mm., and under the pocket-lens project as thick single rings with irregular saw-like septal teeth on the inner margin.

Cœnenchyma in section is very dense; a solid layer may be deposited on the epitheca. The upper surface is an echinulate, flaky reticulum with a soft woolly aspect to the naked eye. Papillæ, more conical or long-cylindrical than nipple-shaped, rise up irregularly in the interstitial spaces without filling them, 1·5 mm. high and 0·5–0·75 mm. thick. They stand, as a rule, isolated, but here and there they fuse together; between the papillæ the cœnenchyma sinks down into concavities, in marked contrast to the tall papillæ. Round the growing edge for about 1 cm. papillate ridges appear, twisted and bent, as if produced by a shrinkage of the surface. The cœnenchyma of the under surface is a smooth, rather dense reticulum.

The specimen *a*, on which this description is founded, appears to have been, in life, of a rose-pink colour. This type is probably allied with *M. tuberculosa* of Lamarck, from which, however, it differs mainly in the size of the calicles, which are much smaller in Lamarck's type.

There is a second specimen, which so closely agrees with this in the specialisation of the cœnenchyma and in the concave intervals between the papillæ that I place it under this head, although it is much thicker (3 cm.), and the calicles, though of the same general character, have

the septa thicker, more laminate and exsert. Its papillæ further show a similar tendency to run in ridges towards the growing edge. It also shows traces of having been tinged with rose-pink in life. It is apparently encrusting a dense mass of Alcyonarian spicules.

a. Tizard Bank, China Sea, 8 fathoms.	H.M.S. 'Rambler.'
b. Palm Island, Great Barrier Reef.	Coll. Saville-Kent.

Note.—The fragment (*b*) catalogued under *M. Brueggemanni*, p. 74, shows the same irregular ridges at the growing edge as *a*, as if produced by shrinkage of the surface, and may belong here. As above stated, it is too small to classify with any certainty.

84. Montipora abrotanoides.

Madrepora abrotanoides, Audouin (*non* Lamarck), Savigny's Egypt, Expl. des planches (1809) p. 233; Polypes, pl. iv. fig. 4.

Manopora nudiceps, Dana, Zoophytes (1848) p. 505.

Montipora crista-galli, Milne-Edwards and Haime (*non* Ehrenberg), Ann. des Sciences Nat., xvi. (1851) p. 56.

Description.—Corallum forming compact tufts of often cylindrical branches, fusing freely together.

Calicles are very distinct and deep, with only six well developed primaries reaching to about the half radius circle.

Cœnenchyma sends up tall, thin, cylindrical, reticular papillæ, which rise up in the middle of the interstices and not immediately in contact with the calicles; the surface reticulum is loose and open. The rounded tips of the branches consist of smooth reticulum with calicles opening in it, but without papillæ.

Neither Ehrenberg nor Klunzinger were able to discover any Red Sea coral like the specimen so beautifully figured in Savigny's atlas, and identified by Audouin as Lamarck's *Madrepora abrotanoides*. Dana first recognised it as a Manopore (= Montipore). There is no reason to doubt that Savigny has given an accurate drawing of the peculiar cœnenchymatous specialisation of the specimen, viz. the single long cylindrical papilla rising up from the middle of a level reticulate interstice. There is one specimen in the Museum Collection from the Red Sea, which may, I think, be claimed as specifically identical. It was formerly labelled by Brüggemann, *M. stylosa*, Ehr. But Klunzinger's fresh description of Ehrenberg's types shows this to be incorrect. The Museum specimen is not a compact tuft of cylindrical columns, but may easily have developed from such. It is a corroded mass forming a fork, with one prong thick and broken into irregular lobes or branches at the tip, and with a living layer 5 cm. deep. On the tip of the other prong the living cap is only 1 cm. deep. The dead portions seem to have been killed by a colonial actinarian, the spreading skin of which, with the shrivelled and dried polyps, are clinging to the specimen. Under these abnormal conditions the form of the specimen may be left out of account, and we have to fall back on other characters. Most noticeable is the presence of the cylindrical cœnenchymatous papillæ, closely resembling those

shown in Savigny's atlas. Here and there, where the surface is irregular, these papillæ fuse to form plates and ridges; but wherever developed free they correspond with those figured. The calicles, again, are distinct from these cylindrical papillæ and have six septa. The tips of the rising branches are free from papillæ, and the developing calicles open on the smooth rounded reticulum. In view of the enormous variations to be found in these corals, the points of positive agreement between this specimen and Savigny's type are so great as to justify the identification.

a. Red Sea. [Register No. 40. 5. 7. 23.]

85. **Montipora fragosa.**

Montipora fragosa, Verrill, Trans. Conn. Acad., vol. i. pt. 2 ("1867–71") p. 502.

Description.—Corallum "subramose or lobate, forming irregular conglomerate masses which have become elevated, and at the summit divide into small, unequal, somewhat acute, very papillose branches, or into large, expanded, flat-topped lobes scarcely papillate above."

Calicles "distinct," scattered among the papillæ; small (0·5 mm.), inconspicuous, with six distinct septa.

Cœnenchyma papillate, papillæ on branches and outer side of lobes very slender; elongated as much as 2·8 mm. in length to 0·5 mm. thick, unequal, roughly spinulose, and directed obliquely upwards. On the summits of the lobes the papillæ are appressed to the surface and become indistinct. On the broad summits of the nearly flat lobes there are no papillæ. On the smaller lobes and on the depressed parts of the larger ones the surface rises into small rounded lobules, or large rounded verrucæ with an openly spinulose lacerate surface.

The colour of the unbleached coral is brownish yellow, in some parts pinkish.

This Montipore, thus described by Verrill, is known only in one specimen, which is apparently in the Yale College Museum. It is specially worthy of note as being the only Montipore recorded, though with some hesitation, from the Gulf of California, "probably from La Paz." The dimensions of the specimen are given as follows: height 3 to 4 inches, breadth at top 4 inches, diameter of branches ·25 to ·75, of larger lobes 1·75, length of free branches ·50 to ·80, length of longest papillæ ·10, diameter of papillæ ·01 to ·02.

In placing it here I am assuming that the papillæ are true papillæ and not tubercles as those terms are here used. The recorded thickness makes this somewhat doubtful, and perhaps the proper place for the type is near *M. hispida*.

86. Montipora tuberculosa.

Porites tuberculosa, Lamarck, Anim. sans Vert., ii. (1816) p. 272.
Montipora tuberculosa, de Blainville, Man. (1834) p. 388.
Non *Manopora tuberculosa*, Dana (= *M. danæ*), Zoophytes (1848) p. 506.
? *Montipora tuberculosa*, Milne-Edwards and Haime, Ann. d. Sci. Nat., (3°) xvi. (1851) p. 58.
Non *Montipora tuberculosa*, Klunzinger, 'Korallenthiere des Rothen Meeres,' pt. 2 (1879) p. 32.
Non *Montipora tuberculosa*, Ortmann, Zool. Jahrb., iv. (Syst.) (1889) p. 498.

Description.—Corallum "incrustans, rudis, indivisa"; calicles minute.

Interstices covered with tall, columnar, spiny tubercles.

The tubercles, scattered over the surface like grains, often unite to form crests or eminences.

Of the specimens labelled *M. tuberculosa* in the Paris Museum, two (Nos. 259*a* and 259*f*) are almost certainly the original types. They are two fragments of a corallum 1 cm. thick, closely encrusting, the calicles 0·4 mm. in diameter, crowded, about 1 diameter apart, margin irregular, interseptal loculi opening freely into the surface reticulum. Primaries conspicuous, well developed, sometimes exsert, one or two directives, one always exsert, visible to the naked eye, and laminate. The section shows a laminate but much perforated streaming layer, a coarse, almost trabecular, upper thickening layer, while the upper surface, which has suffered considerably in the course of so many years, is an open reticulum as if formed of the turned-up edges of jagged flakes. The papillæ are 1 mm. in height, 0·75 mm. in thickness, tall, elegant, symmetrical, but somewhat scattered columns. In section they are like bundles of flakes fused longitudinally and irregularly along the axes of the papillæ, their jagged edges forming the lateral echinulæ. Their fusion into crests and eminences is not now very apparent, owing to abrasion of the surface.

This type is allied to *M. sinensis* and *M. abrotanoides* by its thin columnar papillæ. It differs from these in manner of growth, and from the former in the character of the calicles.

The terms in which Lamarck referred to these papillæ, led me at first to believe that the type must have been tuberculate, as that term is here defined.* His speaking of the surface being scattered over with graniform tubercles was especially misleading to me, as this so exactly describes the appearance in such tuberculate types as *M. peltiformis*, *M. granulata*, and *M. æqui-tuberculata*.

The other specimens in the Paris Museum, provisionally associated with these two original types of Lamarck, appear to me to represent undescribed species.

* On this subject, see Introductory Remarks, p. 9, and footnote.

Group V.—TUBERCULATE.

a. Tubercles single.

87. **Montipora perforata.** (Pl. XXI. fig. 3.)

Montipora explanata (partim), Brüggemann, Phil. Trans., clxviii. (1879) p. 577.

Description.—Corallum closely encrusting (4 mm. thick), without free edges.

Calicles conspicuous, 0·75 mm. diameter; the septa, in two cycles, hardly distinguishable from one another, very minute, mere points projecting from the edge of the deep open fossa.

Cœnenchyma shows in section a very coarse and dense but weakly developed streaming layer, resting (as in most closely encrusting coralla) directly on the epitheca; from this layer stout trabeculæ rise 2 to 3 mm., densely packed together, somewhat irregularly and often very feebly united by junctions. These trabeculæ rise above the surface as short tubercles, which, without being bushy, are jagged and frayed out at the tips. They are about 0·5 mm. high, fairly uniform in size, and distributed over the whole surface. Immediately round the calicle aperture they may be a trifle taller or even fused to form a ring, but these features are not conspicuous.

These tuberculate Montipores from Rodriguez were united, as type specimens of *M. explanata*, Brüggemann, with a purely glabrous specimen (which here retains the name '*explanata*'). The two species seem to me most obviously distinct. On account of the thick and rather long trabeculæ projecting as very small undifferentiated tubercles, I was at first disposed to unite these specimens with *M. mammillata*, but on revising the work concluded that there was no ground for such union.

The two specimens are dark brown in colour, and closely adhering to the corroded remains of former growths.

On account of the encrusting habit and the small development of the tubercles, this type may well stand first in this group.

The specific name applies to the aspect of the calicles as clear round holes like clean punctures, the septal apparatus being visible only on close inspection.

a, b. Rodriguez. Royal Society. 76. 5. 5. {80 / 81 (Types.)

88. **Montipora scabricula.**

Manopora scabricula, Dana, Zoophytes (1848) p. 502, pl. xlvi. fig. 3.
Montipora scabricula, Milne-Edwards and Haime, Ann. d. Sci. Nat., (3°) xvi. (1851) p. 64.
Non *Montipora scabricula*, Quelch, Chal. Rep., Reef Corals (1886) p. 177 (v. *Montipora venosa*).

Description.—Corallum encrusting, glomerate, gibbous, with rounded eminences. The margin thick and folded under.

Calicles very minute, 0·30 to 0·40 mm., with six or twelve septa; in the latter case the primaries are distinct.

Cœnenchyma rather firm, everywhere minutely spinuloso-asperate; spinules (= tubercles scarcely 0·3 mm. long and never lamellate. Tubercles show no special relation to the calicles.

In addition to these characters, Dana adds that the polyps are "olive-green, and the tentacles obsolete." The figures given in the atlas show the corallum coloured a dark slate-blue and the calicles very conspicuous; on figure 3*b* the calicles are drawn with only six very clear, slightly granulated septa. 3*a* shows a fragment of the coral with the polyps retracted, the disc being radially streaked light and dark green alternately; the tubercles are few and very minute as compared with the size of the polyps, with which they stand in no clear relation.

There is no tuberculate coral in the Collection showing these characters.

Dana's specimen was from Fiji, "Mathuata, Isle of Venua Lebu."

89. **Montipora variabilis.**

Description.—Corallum encrusting, thin (3 to 4 mm.), following the unevenness of the substratum, worm-tubes, &c.; edges here and there projecting free without epitheca.

Calicles very variable, from conspicuous, deep, round holes 0·5 mm. in diameter and without any trace of septa, to minute, very inconspicuous, star-like calicles, the apertures being nearly filled up with short thick septa belonging to two cycles. The former occur on the higher portions of the corallum where the growth is most vigorous. The calicles on the under surfaces of the free edges are conspicuous, and surrounded by very visible because slightly projecting rings of cœnenchyma, the septa being only indicated.

The cœnenchyma in radial section shows a laminate streaming layer which, in cross section, is a very open reticulum; the lower surface forms a flat, flaky reticulum covered with very fine hair-like echinulæ, while the uppermost layer tends to be rather solid, owing apparently to the presence of short thick trabeculæ. These rise as tubercles, which are somewhat stout, conspicuous and openly bushy where the growth is vigorous, but elsewhere they are mostly minute foaming processes. Between the tubercles a horizontal flaky reticulum is visible, which is very well developed when the tubercles are small or absent, but very scanty when the tubercles are large. The taller and stouter tubercles show a tendency to be grouped in irregular rings round the calicles, which retain, however, for the most part their own distinct margins. The drooping edges may have their upper surfaces either covered with tubercles, or else be smooth and solid, the calicles opening in the stony surface as minute stars with six very thick septa.

There is one specimen and a fragment of this coral. Owing to the extreme amount of variation which it shows, it is of doubtful value as a separate type. It might be compared in this respect with *M. crassi-tuberculata*, where the same extraordinary variation is also seen.

The type at first sight suggested Dana's *scabricula*, on account of the minute size and

irregularity of the tubercles, but there is too strong a tendency here for the tubercles to group round the calicles, which is not observable in *M. scabricula*.

a. Warrior Island, Great Barrier Reef. Coll. Saville-Kent. (Type.)
? b. (Fragment) Albany Passage, Great Barrier Reef. „ „

90. **Montipora annularis.** (Pl. XXIII. fig. 4; Pl. XXXIII. fig. 15.)

Description.—Corallum builds up, stratum upon stratum, small irregular massive blocks, the living layer being 3 mm. thick and without free edges.

Calicles minute, 0·5 mm. in diameter, scattered, but often side by side in curved rows, with slightly concave valleys between. Six thin, well developed septa, of which two as directives reach far beyond the half radius circle; thin, delicate secondaries are irregularly developed; the septa appear round the inner margin of the protuberant membranous rings which rise with the rings of tubercles.

The cœnenchyma is very solid in section. A tendency to form thick, crowded trabeculæ is obscured by the thickness of the horizontal junctions. The tips of the trabeculæ rise in the interstitial spaces as minute fantastically branching tubercles, the branches, uniting, form here and there an irregular network of thin threads over a smooth floor with small pores scattered about it. Round the calicles the tubercles rise high, closely packed and irregularly fused together by solid white matter to form protuberant rings. Here and there these rings are almost membranous. They are always conspicuous, though not more than 0·5 mm. high. The usually small tubercles in the concave valleys may here and there rise to be as tall as those forming the rings, they then assume the ordinary rounded bushy appearance. There is a great contrast between the delicate threads and tubercles of the surface and the solid trabeculæ and reticular threads of the section.

There is only one small specimen which shows all the delicacy of surface texture characteristic of the New Guinea specimens. The ornamentation of the surface seems to be quite unique, and is especially marked by the sharply defined rings of tubercles forming a kind of false protuberant calicle.

a. New Guinea. Vienna Museum. (Type.)

91. **Montipora stilosa.**

Porites stilosa (H. and E.) Ehrenberg, Korallenthiere (1834) p. 118.
Manopora stilosa, Dana, Zooph. (1848) p. 500.
? Montipora stylosa, Milne-Edwards and Haime, Cor., iii. (1860) p. 211.
Montipora stilosa, Klunzinger, Korallenthiere (1879) p. 30, pl. v. fig. 7, pl. vi. fig. 5.

Description.—Encrusting (4 to 8 mm. thick), with free edges, one layer covering another to build up massive blocks, surface rising into irregular lobes and knobs 5 to 15 mm. broad, 5 to 10 mm. high.

Calicles inconspicuous, deep, margin very irregular, the tubercles standing back a little

from the edge of the aperture. Six rather coarsely granular septa clearly distinguishable. Very small immersed calicles on the under side.

Cœnenchyma stony and tough, a very thin reticular layer rests on the epitheca. Upon this there rests a thick layer of stout and conspicuous, not crowded trabeculæ (4 to 5 mm. long). These rise above the level of the calicle apertures as stout tubercles, irregular in height and distribution; the tallest (1 mm. in height, 0·75 thick) are near calicles but never in actual contact with the calicular aperture. The tubercles are specialised into compact bushy cylinders or knobs. They may be so crowded as to fuse together to form a fresh surface to the corallum, especially on the tops of the lobes or slight eminences. The whole surface, tubercles, septa, &c., as if frosted with fine granules. The tubercles stand in no conspicuous relations with the calicles.

The single representative of this coral in the Collection is one named by Dr. Klunzinger himself, being, in fact, one of his own specimens, and identified by him with Ehrenberg's *stilosa*, which he had been able to examine in the Berlin Museum.

The fragment is an encrusting mass 7 to 8 mm. in thickness. The trabecular layer is very marked, the trabeculæ being of irregular thickness, rising into very compact bottle-brush-like tubercles above the surface. The specimen of this coral in the Paris Museum is tinged with pink, and the bushy tubercles have white tips to their branchlets. It is important to note that the tubercles stand back a little, and do not closely surround the calicle apertures. Another marked feature of the coral is the delicate granulation of the surface, tubercles and septa; it is as if the whole were frosted over. Small patches, however, lose this hoar frost appearance and show a smooth and very solid and stony reticulum. These patches are due to the fusion of the tubercles above described.

The specimen is interesting, because it shows at least three successive growths one over the other; and further, the uppermost was, when gathered, beginning to die down. The finely granular and glassy tubercles appear to melt together into a smooth, white, chalky, opaque mass; over this the succeeding growth would no doubt have spread from some vigorously growing centre.

The encrusting habit results in the lobes and knobs becoming more and more pronounced with each new layer, so that the mass may ultimately tower up ("hochlappig erhoben"). Milne-Edwards uses the term "subdendroide," but it is doubtful whether his description referred at all to Ehrenberg's species.

The living coral is described as of a vivid violet or red colour, visible from a great distance. Yellow varieties are said to occur (Klunz.). Brown or white tentacles (Klunz.) the oral disc being striped white and violet or red (Ehr.). The toughness of the corallum makes the masses difficult to break off (Klunz.).

a. Koseir, Red Sea. Coll. Klunzinger. 86. 10. 5. 15.

92. Montipora villosa.

Montipora villosa, Klunzinger, Korallenthiere, pt. ii. (1879) p. 31, pls. vi. 8, v. ii., x. 2.

Description.—Corallum explanate, 1·5 cm. thick, 5 mm. at the edge.

Calicles round and conspicuous near the edges but somewhat obscured elsewhere. Septal system feebly and irregularly developed. On the under surface the calicles are surrounded by solid rings flush with the surface.

Cœnenchyma. The tubercles are long (2 to 3 mm.), thin, and often pointed, and developed chiefly as palisades round the polyp cavities, which thus often appear to project as protuberant calicles. Between these rings of tubercles the interstices are either flat and show the open reticulum, or else there are small tubercles like spines or granules. The older and thicker portions of the corallum are irregularly raised into warty eminences, and on these the tubercles are not so regularly arranged in rings but are more scattered.

This description is put together from Klunzinger's text and photographs, the original term papillæ being in each case changed into tubercle, according to the terminology here used. There is only one explanate tuberculate Montipore from the Red Sea in the National collection, and this is a single thin leaf, and was originally labelled *M. foliosa*. It differs from *M. villosa* in the shortness and crowded state of the tubercles, which do not in any conspicuous fashion form palisades round the calicles. It seems to me most likely allied to *M. rus* of Forskål (p. 140).

Dr. Klunzinger compared the method of growth with that of *M. patinæformis* of Esper (see p. 97), but the cœnenchymatous specialisation is quite distinct.

93. **Montipora nodosa.**

Manopora nodosa, Dana, Zooph. (1848) p. 501, pl. xlvi. figs. 2, 2*a*, 2*b*, 2*c*.

Description.—Corallum encrusting, glomerate, with edges thin, free for 3 to 5 cm., and slightly turned up; it forms thick "tuberculate" masses, with the "tubercles" (= lobes) mostly conical and like rudimentary branches.

Calicles very minute, 0·4 mm., six-rayed, a few on the smooth under surface of the margin are very minute and slightly prominent.

Cœnenchyma "hardly fragile, spinuloso-asperate," spinules very crowded, scarcely 1 mm. long, a little compressed and obtuse.

This type is from the Fiji Islands, (Mathuata, Island of Venua Lebu). The living polyps are pale lilac with obsolete tentacles, and the disc with twelve short crenations and a white margin. This is an encrusting tuberculate Montipore, the surface of which rises up into prominences like incipient branches.

There is no specimen in the National Collection corresponding with it.

94. **Montipora mammillata.** (Pl. XXI. fig. 4.)

Description.—Corallum thick, about 1 cm., encrusting, forms small rounded bosses.

Calicles unevenly distributed, crowded on one side where the surface is tuberculate, scattered on the other where the surface is smooth; large, just under 1 mm., conspicuous like deep punctures. Septal apparatus feebly and irregularly developed round the aperture, one or two directives as short stout projections from the calicle margin, a few primaries and secondaries appear deep down in the fossa.

Cœnenchyma shows in sections a thick, basal, solid layer, a dense and not pronounced streaming layer; the trabeculæ of the thickening layer are from 5 to 7 mm. in length. They are stout and nodulate, and joined at regular distances by thick junctions, round or oval pores being left which are largest near the surface, i.e. where the trabeculæ are thinner and the cœnenchyma less dense. Where the trabeculæ rise above the surface as tubercles, their tips are ragged but not swollen or bushy; some rise higher than others, and become clear, solid knobs which begin to join with the adjacent tubercles in the typical manner for the thickening of the cœnenchyma. On the smooth side of the corallum the projecting trabeculæ are not so apparent as tubercles, they appear more as the rough ends of the threads of the reticulum.

There is only one specimen of this type. On account of the length of the trabeculæ, I was disposed to unite it with *M. solida*, which I have, however, now transferred to the glabrous group. The corallum consists of two bosses of thick coral which appear to be encrusting the remains of a Madrepore. We have, unfortunately, no means of ascertaining what the shape of a large specimen would be. It is possible that *M. cactus* may spring from such a young stage, but the tubercles of *M. cactus* are much more highly specialised.

a. Capricorn Island, Great Barrier Reef. Coll. Saville-Kent. (Type.)

95. **Montipora cactus**. (Pl. XXI. fig. 5; Pl. XXXIII. fig. 16.)

Description.—Corallum rising into a thick cylindrical upgrowth (at least 20 cm. high), giving off a few thick, knob-like branches. The growth is of about the same thickness all the way up, 2 to 3 cm. except where branches are growing out. The basal portion dies away but is covered over by a living layer, while the branches of other corals with which the rising column comes in contact are grown round and perhaps utilised for extra support.

The calicles are conspicuous, deep, open, neatly star-shaped, 0·75 mm. in diameter, with six short thick septa reaching to about the half radius circle, with traces of a second cycle; two directives generally visible to the naked eye; irregularly distributed on the bulging portions of the surface, where they may be 1 to 2 mm. apart, but crowded in depressions. Aperture of the calicles as a rule well defined.

Cœnenchyma shows, in section of the stem, a laminate axial strand of open reticulum from which stout trabeculæ, 7 to 8 mm. long, radiate outwards, densely packed towards the centre but wider apart towards the surface. These are joined together by stout cross bars, in marked contrast to the thin spines which form the septal series seen in longitudinal sections of calicles. Above the surface of the interstices these trabeculæ rise as rounded tubercles, looking solid but finely frosted to the naked eye, but under the lens seem to be covered with fine flaming points. They seem to be best developed in the most protected places, where they are about 1 mm. thick and 1 mm. high, and so crowded and compact as quite to obscure the true interstitial surface. Here and there tubercles form flat plates as if two had joined together. No conspicuous tendency to form rings round the calicles. The tubercles are much more

pronounced and crowded on one side of the coral than on the other. Where the calicles are very crowded in the hollows, the interstices well up above the level of the calicles as a delicate, very open and friable reticulum.

The type of this coral consists of two fragments which were unlabelled, and which are seen fitted together in Pl. XXI. fig. 5. The tips of two branches of a Madrepore have been touched, and partially incorporated in the coral substance. The specimen is, as far as I know, quite unique; unfortunately there is no record of its locality.

a. Locality not recorded. [Register No. 97. 10. 9. 1.] (Type.)

96. **Montipora incrustans.**

Montipora incrustans, Brüggemann, Abh. Naturw. Ver. Bremen, 2, v. (1877) p. 398.

Description.—Corallum explanate with uneven surface, creeping over foreign objects as a thin layer with free edges. Epitheca in irregular patches. The thickness varies from 5 to 15 mm.

Calicles completely immersed, very small, 0·3 mm. in diameter, distant from one another about one and a half diameters. Two cycles of septa, well developed primaries twice as long as secondaries. The calicles on the under side are much more visible and are surrounded by fine, thin, cœnenchymatous rings. The cœnenchyma is a rather loose reticulum, and the upper surface is covered by delicate pointed processes (tubercles) which make it look hairy or velvety. The under surface is smooth and reticulate.

This is the substance of Brüggemann's description of the type specimen from Mauritius preserved in the Jena Museum. He quotes also a note of the collector, that this coral is a "reef-builder." This specimen was claimed by Ortmann * as belonging to *M. tuberculosa*, Lamarck. (See, however, p. 112.)

There is one specimen in the National Collection from Rodriguez which was identified by Brüggemann himself as belonging here.† It is but a small fragment from a free edge, some 5 cm. deep and 4·5 cm. wide, 3 mm. thick at the edge, and reaching about 6 mm. in the thickest part. It is, however, fairly typical of the method of growth described. A few characters to be added to the above are (1) the streaming layer tends to be laminate, and towards the growing edge where it comes to the surface it twists up in jagged flakes; (2) these flame-like processes gradually pass into the regular tubercles with their submerged portions (trabeculæ). The tubercles are very irregular in size and grouping—here and there bunched together, and tall—but showing no conspicuous ring formation round the calicles. In section the trabeculæ are often thick and crowded, and rest upon a coarse reticular streaming layer. On the under surface an epitheca develops in patches, and may be partly grown over by protrusions of light reticulate cœnenchyma full of calicles. These frequently protrude, even opening at the top of crater-like cones or cylindrical tubes.

a. Rodriguez. Royal Society.

* Zool. Jahrb., iv. Syst. (1889) p. 498. † Phil. Trans., clxviii. (1879) p. 577.

97. Montipora stellata.

Description.—Corallum not closely encrusting, free edges, with well developed epitheca to within 1 cm. of edge; about 1 cm. thick at 6 cm. from edge. Edge from 3 to 4 mm. thick. Surface very uneven.

Calicles elegantly star-shaped, from 0·50 to 0·75 mm. in diameter, crowded, without any definite margin. Six well developed primaries extending beyond the half radius circle: one of them is specially pronounced, frequently laminate, and reaches nearly to the centre of the calyx: small secondaries irregularly developed. On the under surface the calicles are minute, star-like and numerous, surrounded by thick solid rings deeply cut in to form the interseptal loculi.

Cœnenchyma shows a conspicuous layer of streaming laminate reticulum 3 to 4 mm. thick; this forms the growing edge. This layer bends up and only gradually changes into the trabecular layer. The trabeculæ are stout and closely packed together, the junctions being thin and inconspicuous. The tips of the trabeculæ rise above the surface to form dense crowds of tubercles, irregular in size and distribution, small groups rising taller than the rest, and here and there forming tall rings round calicles. They average 0·5 mm. thick and 1 mm. high, and are bushy, round-topped columns, their fine branchlets being generally arranged in longitudinal series, making the tubercles look striated when seen sideways under the lens. On the eminences the tubercles may coalesce to form short ridges, and round the growing edge there is a ridge formation due to the streaming layer and prior to the formation of tubercles.

Under this heading I have classed two fragments of tuberculate corals which agree in most points, but differ chiefly in the size of the tubercles. In most other respects they resemble one another sufficiently to justify their provisional juxtaposition.

The running together of the tubercles to form gyrating ridges, especially on eminences, is more pronounced on *a* than on *b*, but, owing to the fact that this phenomenon is a very common one and may be due to the accidents of growth, too much stress cannot be laid upon it. The ridges are not radially arranged round the edges as in *M. effusa*, but twist about irregularly. The patches, however, in which this ridging takes place are very limited, while over the greater part of the surface the tubercles are simple and free. While here and there a ring of tubercles rises round a calicle higher than the rest, there is no special marking of the positions of the calicles by the heights of the tubercles. They rise close round the calicle aperture.

a. Rocky Island, Great Barrier Reef. Coll. Saville-Kent. (Type.)
b. Cleveland Bay, „ „ „ „

98. Montipora inconspicua.

Description.—Corallum forms minute, encrusting patches, 2 to 3 mm. thick. Free edges are contained in a well developed, wrinkled epitheca which curls upwards.

Calicles 0·5 mm., 1·5 to 2·0 mm. apart, very inconspicuous, fossa nearly filled up with two cycles of septa. Primaries thick, not exsert, nearly reaching to the centre; secondaries thin and half as long as primaries, often irregular.

Cœnenchyma, character in section not shown. Surface thickly covered with minute round tubercles, just distinguishable above the surface yet quite distinct from one another, like minute woolly spheres without sharp outlines. Those round the calicles are slightly more developed, but all are so low that the calicles appear hardly at all immersed.

The single specimen of this tuberculate Montipore occurs in two small patches struggling for existence with the more vigorously growing stock of *M. bolsii* (see p. 34). It is thus one of the explanate Montiporans which, with *M. bolsii* and *M. exigua*, form the laminated crust mentioned in the descriptions of those corals. All three of them have remarkable superficial resemblances. The differences, as seen under a pocket lens, necessitate their being described under different headings. Both the small patches of this minute tuberculate coral are being gradually arched over by free edges of the larger *M. bolsii*.

a. (With *M. bolsii*) Billiton. Coll. Bolsius. 83. 7. 24. 103. (Type.)

99. Montipora challengeri. (Pl. XXII. fig. 1; Pl. XXXIII. fig. 17.)

Montipora effusa, Quelch (*non* Dana, *nec* Milne-Edwards and Haime), Chal. Rep., Reef Corals (1886) p. 178.

Description.—Corallum thin and explanate, horizontal, slightly dish-shaped, attached by one side, surface uneven, irregularly translucent, the edge closely reflexed for about one centimetre; 2 mm. thick at growing margin, 5 mm. near centre. The epitheca well developed, wrinkled, runs everywhere under the reflexed margin, bends out over it and may overlap it, with here and there a second incipient reflexion.

Calicles inconspicuous, minute, less than 0·5 mm., scattered, appearing in two forms at the surface. Those which open on the level portions of the corallum are immersed and irregular, and generally have few septa at the aperture, which is not sharply circumscribed; only when held up against the light do the typical six primaries appear, with secondaries all very irregularly developed. Those calicles which are surrounded by small groups of tubercles show the typical radiate character at the surface, but are very irregular in shape. On the reflexed under surface the star-like calicles are immersed in a coarse open reticulum with which their borders are in sharp contrast.

The cœnenchyma consists in section of a laminate streaming layer in close contact with

the epitheca, except where the edge is or has been reflexed, in which places a trabecular layer consisting of long thin threads runs down to the epitheca. Above the streaming layer there is an irregular trabecular layer, consisting here of short stout trabeculæ, there of fine points. This arrangement shows at the surface as a smooth, very open, thread-like reticulum, interrupted here and there by small irregular groups of feathery tubercles. These tubercles, which are very irregular in size and have no sharp outlines, are generally associated with calicles, but may stand up singly above the open reticulum. The groups of tubercles (generally five) which irregularly surround the calicles, never form symmetrical rings, but small mounds rising about 1 mm. high and some 2 mm. in diameter, and scattered 2 to 3 mm. apart, and in marked contrast to the intervening spaces of smooth, open, thread-like reticulum.

The type specimen differs from all other Montipores in the peculiar specialisation of its cœnenchyma. It is an explanate semicircular growth of some 16 cm. radius. The central parts are thin and translucent, arching high and free over dead former growths, by one of which it appears to have been laterally attached to the substratum. The section of the corallum, and also the surface of the wrinkled epitheca, show that the growing edge had already been reflexed twice at earlier stages of growth, the new edge in each case subsequently growing out further, and again bending under. The surface is made somewhat irregular by Balanids, many of which have been grown over by the coral.

The specimen was determined as *M. effusa* for the 'Challenger' Report, but the specimens now described on p. 144 and figured (Plates XXV. and XXVII.) agree better with Dana's description and figure of that species (Tahiti).

a. Zamboanga (in three fragments). H.M.S. 'Challenger.' (Type.)

100. **Montipora listeri**. (Pl. XXXIII. fig. 18.)

Description.—Corallum thin, explanate, with edges irregularly bent back. New growths develop upon the edges of the old; 2 mm. thick at margin, increasing to 6 mm. The epitheca from 1 mm. to 1 cm. behind the growing edge.

Calicles conspicuous, star-shaped, about 0·5 mm., cleanly cut out of the thick smooth flakes of the cœnenchyma, close together in irregular concentric rows, which rows, however, may be 2 to 3 mm. apart. Parts of two cycles of septa, not reaching to the half radius circle, often irregular but distinct, the directive primaries conspicuous; fossa open. On the under surface the calicles are larger and more conspicuous, each being surrounded by a prominent ring beset with two cycles of minute septal teeth.

Cœnenchyma round the growing edges and on the under surface, a loose, thread-like, very open reticulum. This forms a solid layer resting on the epitheca. The streaming layer is coarse and composed of very thick threads, from which stout, nodulated and closely packed trabeculæ are developed. These rise above the surface as tubercles, which are feathery and hence have no distinct outlines. They are of two kinds, and the contrast between them lends the coral its

chief peculiarity. Tall, irregular tubercles rise up in the proximal walls of the calicles at the outer edges of their solid ring-like margins, but seldom surround the whole calicle. These tend to raise the whole calicle a little above the surface. The interstitial tubercles are like small, scattered, feathery grains rather far apart, and rising up from a solid-looking layer of stout flat flakes with large round pores. The interstices are thus in marked contrast to the irregular eruptive calicles with their one or two tall tubercles. On the under surface the reticulum is so open that the meshes are very conspicuous.

There is only one fragmentary specimen of this type. It is a new growth started at the edge of a former dead frond. It is 6 cm. deep and 11 wide, and the dead growth to which it is attached is about the same size and shows essentially the same method of growth. I have been unable to associate it with any other specimens in the collection. Like the last two species its tubercles are feathery and indistinct.

a. Tongatabu. J. J. Lister, Esq. (Type.)

101. Montipora grisea.

Description.—Corallum thin, explanate, apparently forming flat lobate fronds broader than they are long, 2 mm. at growing edge, 4 mm. at 6 cm. further in. Epitheca to within 1 cm. of margin.

Calicles inconspicuous, except at growing edge and on young fronds, scattered, 0·3 mm. in diameter, star-like, with well developed primaries and traces of rudimentary secondaries. On the under surface the calicles are hardly visible to the naked eye, excessively minute, very irregular in shape, and with parts of two cycles of septa.

Cœnenchyma a very thick, open, filamentous streaming layer, forming on the surface of the margin numerous feathery processes which point outwards and generally rise as the proximal walls of sloping calicles; as the cœnenchyma thickens these processes are immersed, and the surface is purely reticular. In this reticulum short stout trabeculæ appear, showing every stage of their development as submerged tubercles. These latter are small rounded bushes, so loose and feathery as to have no sharp outline to the naked eye. They are very irregularly distributed in uneven groups, tending to be taller the further away they are from the growing edge, towards which they all slope excepting on the oldest central portions of the stock. They rise within the interstices and seldom from the immediate walls of the calicles, the apertures of which are distinct. The under surface is purely reticular, the threads being close and thick.

The specimens on which this type is founded are three small fragments, two of which appear to be regular lobate fronds, broader than they are deep, and in both cases the posterior lateral lobes of the broadening frond form folds with the flat stalk of attachment. The basal parts of the fronds are corroded. The depth of the living zone is only 5 cm. The section of the corroded portion of the old stock shows the same thick spongy streaming layer above described; here and there it has deposited a solid layer on the epitheca, and the trabeculæ are

distinct and long. The type appears to be peculiar in the development of the cœnenchyma. These specimens, as well as the specimen of *M. listeri*, have the same blue-grey colour common to the Turbinarians and Astræoporans from this locality.

a, *b*, *c*. Tongatabu. J. J. Lister, Esq. 91. 3. 6. 117. (Types.)

a is the largest frond, 10 cm. broad; *b* is a portion of a young frond which was about 6 cm. broad; *c* is a bent, crumpled and corroded fragment of some old stock being re-grown over by fresh coral.

102. **Montipora minuta.** (Pl. XXIII. fig. 3; Pl. XXXIII. fig. 19.)

Description.—Corallum minute, flat, or scallop-shaped growth of varying thickness, from 1 to 5 mm. Epitheca almost to growing edge, may, however, in thick specimens, leave from 1 to 2 cm. of under surface free.

Calicles are conspicuous on thin specimens, being mostly raised above the surface by irregular clusters of tubercles which are generally taller and more numerous on the side of the calicle away from the growing edge. The aperture is about 0·5 mm. across, with two cycles of septa, generally regularly developed, the primaries reaching slightly beyond the half radius circle. Where the under surface is not covered by epitheca it is covered with calicles, which are open as very minute pores, and only seen to be star-like with a pocket-lens.

The cœnenchyma shows an open streaming reticulum depositing a solid layer upon the epitheca, and here and there in some specimens breaking through the latter to form knob-like drops which are either entirely overgrown by epitheca, or still show an open calicle or two. Towards the upper surface the streaming layer bends up to form a thicker or thinner layer, according to the thickness of the stock. At the growing edges the streaming layer may rise as radial papillate ridges, but the rest of the surface is tuberculate. The tubercles are of all sizes, compact, cylindrical, with sharp outlines to the naked eye. They rise from trabeculæ, which also vary greatly in thickness, some reaching nearly 1 mm. in diameter. The tubercles tend to rise in irregular groups round the calicles, but do not form regular rings; this is most marked in the thinnest specimens, for in these the surface between the groups of tubercles may be concavely sunk. In thicker specimens tubercles may appear very irregularly all over the surface even between the groups associated with the calicles.

There are five specimens of this coral, which is closely linked with the specimens described on p. 91 under the specific name *M. pulcherrima*; specimen *g* of this latter species is a transition form, showing the gradual substitution of tubercles for radial ridges. These radial ridges can still be traced in the specimens now under discussion. The alliance between these two types is closely paralleled by that between many of the larger and more tropical foliate Montipores. *M. prolifera*, for instance, is entirely papillate. *M. foliosa* is partly papillate (with papillate ridges) and partly tuberculate, while *M. solanderi* is almost entirely tuberculate. So that if we accept Mr. Bassett-Smith's suggestion that some specimens of *M. pulcherrima*

are simply (minute) specimens of *M. prolifera* of Brüggemann, while others are small examples of *M. lima*, Lam. (= *M. foliosa*), then the specimens here named *M. minuta* might well be classed under the heading *M. solanderi*. It is clear that we have here two parallel series of forms, the smaller series being in the less favourable northerly regions. I keep the two series quite distinct, because we have no evidence of the relationship of the smaller forms with the larger tropical forms, and also for the purposes of more exact description of the various growth-forms than would be possible if I had thrown all these small and beautifully coloured specimens into the series of examples which illustrate the larger and more important types.

The difference in the thickness of the specimens may be due to age: the thinnest (*d*) is a complete ear or scallop-shaped stock about 5 cm. in diameter (Pl. XXIII. fig. 3). It grows out freely from a lateral point of attachment to some previous growth from which it appears to have sprung. The other specimens are all fragments from the edges of larger stocks. Most of the specimens suffer from the presence of young Balanids.

a, b, c. Macclesfield Bank, 13 fathoms (fragments).	Coll. Bassett-Smith.	92. 10. 17. 137. (Types.)
d. Macclesfield Bank, 13 fathoms (thin young stock).	„	„
e. Macclesfield Bank (fragment distorted by Balanids).	„	„

103. Montipora lichen.

? Manopora lichen, Dana, Zooph. (1848) p. 492.
Montipora lichen, Brüggemann, Phil. Trans., clxviii. (1879) p. 578.

Description.—Corallum explanate, 5 mm. thick, surface more or less encrusting with free "bi-facial" edges, the coral often running back over the epitheca, which thus only appears in patches.

Calicles small, 0·5 mm. diameter, star-like. One or two cycles of septa. Primaries thin but reaching to the half radius circle, most of the calicles surrounded by a well defined ring of tubercles so as to appear as if the calicles themselves were protuberant; groups of two or three mounting together 2 to 3 mm. above the surface. Round the growing edge the calicle apertures slope outwards, and only one or two tubercles grow out slantingly over them. A side aspect of these calicles, hooded over by the tubercles, suggests the nariform calicles common among Madrepores. On the under surface calicles crowded, often protuberant owing to rings of tubercles of various heights and compactness.

Cœnenchyma shows in section the streaming layer. The lower threads do not thicken, but, bending perpendicularly and joining together by junctions, end on the free under surface as fine single points or else as well developed feathery tubercles. At a distance from the growing edge the surface gets smooth and compact. The threads of the upper layer greatly thicken, and form short stout trabeculæ, distinct and rather far apart. These trabeculæ project above the

interstitial spaces as very delicately feathered tubercles, which are nevertheless fairly sharply outlined to the naked eye. The six trabeculæ which give rise to the septa form a close protuberant ring round the calicles. On the under surface the tubercles surrounding the calicles may fuse into thick, finely echinulate rings; this is especially the case where the calicles are somewhat far apart, elsewhere calicles may rise as hemispherical eminences, or again be all level with the surface.

Manopora lichen is Dana's second species of his division of the genus characterised by "tubiform calicles." His first species (*gemmulata*) has been shown by Verrill to be a true Turbinarian, and some doubt attaches to the other two also, because protuberant calicles are certainly rare in this genus. (See, however, *M. stalagmites*, and Introduction, p. 10.) There are three specimens from Rodriguez in the National Collection labelled *Montipora lichen* Dana, by Brüggemann, Dana's original type being apparently from Tahiti, Society Islands. With these I have associated, with much hesitation, three specimens from the Great Barrier Reef.

These six specimens, forming a most unsatisfactory group, are united primarily by one common feature. They all show close rings of tubercles round the calicles, which, to the naked eye, look like protuberant walls. This character occurs also in *M. foliosa* and *M. solanderi*, but in them it, as a rule, appears only irregularly, sometimes apparently as a transitional stage in the thickening of the corallum, a little way below the growing edge.

Two of the Rodriguez specimens are peculiar in being flat portions of corroded stocks, the edges of which have been regrown over above and below, the creeping edges tending everywhere to turn up; both the calicles and the tubercles are a little larger than are those of the Australian specimens.

These latter form another group not differing more from one another than do the three Rodriguez specimens. The grouping, however, can only be provisional. The finer shades of difference between these tuberculate Montipores are extremely puzzling, and only examination of long series could give one confidence in dealing with them. Unlike the Rodriguez specimens with their encrusted margins, these are explanate with thin edges sloping upwards. The under surface shows, however, the same tendency to proliferate and to form irregular knobs, &c.; many of the calicles of the under surface are also protuberant upon hemispherical elevations; the origin of these walls from tubercles is, however, obscured. On specimen *d* the tubercles are smaller and very crowded. On *e* the tubercles are larger and not so sharply outlined; the calicles upon the sloping sides are markedly nariform, the aperture being greatly tilted towards the growing edge, and sometimes with no more than one large tubercle sloping outwards over it. Specimen *f* is a fragment broken from the thin edge of a coral which evidently closely resembled *e*.

In all the specimens the surface is very uneven, owing to the tendency of tubercles here and there to grow up and carry single large calicles above the rest.

a, b, c. Rodriguez.	Royal Society.
d. Thursday Island, Great Barrier Reef.	Coll. Saville-Kent.
e, f. Adolphus Island.	„ „

104. **Montipora scutata.** (Pl. XXII. fig. 2; Pl. XXXIII. fig. 20.)

Description.—Corallum thin, horizontal, semicircular, dish-shaped, with gradually rising edges. Growing edge 2 mm. thick, 5 to 6 mm. in the thickest central region, which is, however, thickened by successive thin layers flowing back from the edge over corroded previous growths which serve to attach the stock. An epitheca appears here and there under the creeping edge, and is well developed under those portions of new growth which happen to arch freely over the old. In sections no line of division can be made out between the successive layers except where they grow free of one another. In the under surface the epitheca is developed only in patches, the greater portion of the whole being free.

The calicles are small, 0·75 mm., and star-like, deep and conspicuous; portions of two cycles of very thin septa, the primaries being of unequal lengths, one, however, generally reaching beyond the half radius circle. The periphery of the aperture seldom clearly seen on account of the crowd of tubercles. On the under surface the calicles are crowded, more regularly star-like, with thick, stout septa of irregular length, and forming portions of two cycles; the apertures, which average about 0·5 mm. across, are surrounded by solid rings of cœnenchyma which are very conspicuous, 0·75 mm. in diameter, and are all slightly prominent, here and there standing nearly a millimetre above the surface.

The cœnenchyma consists in section chiefly of the reticular streaming layer; the upper thickening layer is thin, the trabecular sunken portions of the tubercles being very little developed. These latter are flat plates expanding a little as they rise, and not at all unlike the scales on the wings of butterflies. These plates, though larger near calicles than elsewhere, are not arranged radially round the calicle apertures, but very nearly parallel to one another. While the direction in which the scale-like tubercles stand is by no means the same over the whole corallum, there is a decided tendency for them over definite areas to face the same way. They are largest and most crowded in the older and deeper central portion of the dish-like corallum; towards the growing edge they occur more in groups round the calicles.

There is only one undoubted specimen of this coral, showing the peculiar specialisation of the tubercles evenly developed over the whole surface. It shows a remarkable division line on both upper and lower surface (see Pl. XXII.). On the upper it is a thin, reticular, creeping edge, with here and there an epithecal film visible, while on the under side there is a white film following the same line as does the creeping edge on the upper side. That this coral is regenerated by successive layers, examination of the older central region conclusively proves, and yet the two halves of the coral on the two sides of the line just described do not seem to differ in thickness. This is not easy to understand, but probably the one half of the coral was beginning to die down, and the other more vigorous half was threatening to grow over it. More puzzling still is the fact that on the under surface the edge of the vigorous region is covered by a thick film, which is quite flush with the old coral and does not spread over it.

The character of the tubercles above described appears to be unique, and fully justified the establishing of a new species.

a. Thursday Island. Coll. Saville-Kent. 92. 12. 1. 285. (Type.)
b. Warrior Island (a fragment). „ „

There is another specimen which shows many of the same characters, being a dish-shaped growth creeping over a former thicker and older growth by which it was attached, and having calicles both on the upper and lower surface very much as in the type. It differs, however, from the type in that the tubercles are for the most part cylindrical flames; the scutate character of the tubercles only appearing here and there in patches, e.g. round the bases of the eminences. Wherever they occur, however, they tend to run in rows edge to edge, as in the type. On this account it seems better to place it here. At first sight it appears of quite a different type, the tubercles being closely and evenly distributed over the whole surface, looking like fine grains to the naked eye, only seldom growing larger and more prominent round calicular apertures. It is very doubtful, of course, whether a few patches of scutate scales justifies its association with the type. On the other hand, this fact shows the two to be related forms, and is of weight taken together with the similarity in method of growth and formation of calicles.

The section of the dead portion by which the specimen was attached, and on which it spread like a dish with the edges curled up, is very thick, nearly 1 cm., with thick reticular and trabecular layers. The trabeculæ, 5 mm. long, are stout and crowded, though separate and distinct; the junctions are short, thin cross bars.

c. Albany Passage, Great Barrier Reef. Coll. Saville-Kent.

105. **Montipora peltiformis.** (Pl. XXIII. figs. 1 and 2.)

Montipora patula, Quelch (*non* Verrill), Chal. Rep., Reef Corals (1886) p. 174.

Description.—Corallum disc-shaped, thin, 2 to 4 mm., transmitting light especially through its polyp cavities, growing horizontally across the tips of the branches of other corals. Hence upper surface somewhat uneven and thrown up into small irregular knobs.* On the under surface an irregular patchy epitheca, between the openings in which the corallum protrudes and tends to hang down, as if to attach itself to fresh supports. The epitheca often forms a cup or saucer-like border to such protruding portions of the corallum.

Calicles on the upper surface crowded, nearly regularly distributed, deeply sunk among the tubercles, about 0·5 mm. in diameter, with two, sometimes three, cycles of delicate septa, among which the primaries are distinguishable. Directives often present, fossa distinct and deep. On the under surface the calicles (especially on the protrusions through the epitheca) extremely minute, even to less than 0·25 mm., and often densely crowded.

The cœnenchyma shows in section an open laminate streaming layer coming to the surface at the growing edge. This layer occupies nearly one-half of the thickness of the corallum.

* Due partly perhaps to worm-tubes.

There is no dense layer resting on the epitheca. The trabeculæ of the thickening layer are short, stout, very smooth and glassy, but of very irregular shapes. These rise regularly above the surface as finely branched but minute tubercles averaging 0·5 mm. high, crowded, evenly distributed over the whole surface except just round the growing edge. Though branching, they are so small as to appear compact to the naked eye, like minute white seeds with which the whole surface is evenly strewn. They rise straight up from the walls of the calicles, and are arranged as single rows between the more crowded calicles, but in other parts packed closely together so as to fill up the whole interstitial space. The cœnenchyma of the under surface is smooth, the minute calicles opening in a close, solid reticulum, each aperture being, as a rule, surrounded by a single thick ring, notched on the inner circumference in such a way as to show two cycles of septa.

The single specimen is one of the 'Challenger' reef corals from Amboyna, and was identified by Mr. Quelch with Verrill's *Montipora patula*. It certainly belongs to the same tuberculate group, but, according to the structural variations here adopted as of systematic value, it must be separated from it owing to the very different character of the cœnenchyma (see p. 144). The peculiarly regular size and distribution of the tubercles, as if the whole surface were evenly strewed with minute white seeds, would certainly have been mentioned by Verrill had it occurred in his specimen. The method of growth of the specimen horizontally across the tips of branching Madrepores is probably not accidental, inasmuch as the protrusions of cœnenchyma through the epitheca appear to be a provision for the finding of fresh points of attachment.

a. Amboyna. H.M.S. 'Challenger.' (Type.)

106. **Montipora granulata.** (Pl. XXXIV. fig. 1.)

Description.—Corallum forms large explanate fronds with thin edges, 2 mm., slightly wavy, but not bent up. The centre of the frond dies away, the living zone being about 8 to 10 cm. deep. The frond gradually attains a thickness of 7 to 8 mm. The epitheca appears in irregular patches.

The calicles tend to be arranged in irregular wavy rows, roughly parallel with the growing edge and about 1 mm. apart. Within the rows the calicles may be almost in contact. They are about 0·5 mm. in diameter, and conspicuous in the older, thicker portions of the corallum, but obscured in the younger parts by the irregularity of the clumps of surface tubercles. The primaries are well developed and reach to the half radius circle. The absence of secondaries renders the interseptal loculi large and conspicuous. On the under surface the calicles are numerous and minute, often mere pinholes, with six septa.

The cœnenchyma has a well developed, lamellate streaming layer, which passes both upwards and downwards into trabecular layers. In the lower the trabeculæ are not very well defined, short and compact, and tend to make the surface dense. The upper layer is remarkable for its tall, nearly smooth, cylindrical trabeculæ, hardly joined together at all but standing side by side close together. Abrasion of the surface causes them to tumble out. Their tips

project as small rounded tubercles covered with very fine and inconspicuous points. In the younger portions of the corallum these rise highest round the calicles, and where these latter are in rows the tubercles surrounding them also form dense rows, with concave and often smooth valleys between. In the older portions of the stock the whole surface is smooth, and consists of a level floor composed of the tops of the rounded tubercles. The calicles are marked by rings of tubercles slightly larger and just raised above the general level. The tubercles over the whole surface are singularly uniform in size and shape, about 0·25 mm., looking like closely packed grains.

There are six fragments, which piece together to make a large, nearly flat and rectangular frond some 14 cm. deep by 18 broad. One side has grown under, the other is broken away. The complete form is therefore unknown. The character of the tubercles and the regular shape and freedom of the trabeculæ are quite unique. *M. peltiformis* also has uniform tubercles like closely packed seeds (cf. also *M. cactus*), but seen under a pocket lens these are round open bushes, whereas in this type they are solid round knobs appearing slightly hairy; they are, however, more bushy near the growing edge. The freedom of the trabeculæ so that they easily tumble out, is a remarkable feature in this specimen; the interstitial floors between the tubercles shown in the figure (Pl. XXXIV. fig. 1) only appear where the coral is beginning to die down.

a. (In six fragments), Torres Strait. Prof. A. C. Haddon. (Type.)

For a description of two allied specimens in the Cambridge University Museum, see the Appendix.

107. **Montipora æqui-tuberculata.**

Description.—Corallum thin, explanate, with edges translucent, slightly lobate, curved up and wavy, 2·5 mm. thick, 6 mm. 4 cm. further in. Epitheca not within 4 cm. of growing edge.

Calicles scattered, average 1·5 mm. apart, small, distinct, hidden by the outwardly sloping tubercles, excepting when looked at from the edge or from above. Single calicles or small groups are raised up by the tubercles so as to form small excrescences on the surface. Aperture irregular, 0·5 mm. across; six, not very symmetrical, primaries, thin, reaching nearly to the half radius circle. A few very rudimentary secondaries. On the under surface the calicles are crowded, of all sizes from large conspicuous rings 1 mm. in diameter, to minute, irregular breaks in the cœnenchyma; septa weakly developed.

The cœnenchyma shows in section a well developed laminate streaming layer, very open and friable at the growing edge. The lower thickening layer is a compact reticulum yielding the solid rings round the calicles. The upper thickening layer is of very irregular development, the trabeculæ being long and regularly palisade-like in the thicker portions. The tubercles are very uniform in diameter and general appearance, as erect cylindrical flames. On the level portions these are short, but lengthen greatly round the bases or on the slopes of the small excrescences above mentioned. Between the tubercles one can see down into a stout porous reticulum.

There is a small fragment broken from the edge of a larger stock; in the regular uniform appearance of its tubercles it belongs near to the two last types, but it cannot be identified with either of them.

a. Albany Passage. Coll. Saville-Kent. (Type.)

Near this again is another small fragment, also broken from the edge of an explanate growth. An epitheca develops at a varying distance from the edge, 1 to 2 cm. The chief difference lies in the tubercles, which, though somewhat of the same character, are very much smaller. They have, however, the same minute graniform appearance. As in the type, the streaming layer is laminate, but the edge is flat and not curled up, and the laminate layer flames up into jagged ridges and processes for a greater distance from the edge than it does in the type. The fragment is small, and the full characters of the tuberculate surface are perhaps not shown.

b. Thursday Island. Coll. Saville-Kent. 92. 12. 1. 21.

108. **Montipora expansa.**

Manopora expansa, Dana, Zooph. (1848) p. 498, pl. 45, figs. 2, 2*a*, 2*b*, 2*c*, 2*d*.

Description.—Corallum foliaceous, thin (3 to 4 mm.) and fragile, wide-spreading, often dish-shaped, "a little ascending, sometimes encrusting in part," "margin undulate, scarcely plicate," epitheca (?) to "within 5 cm. of the edge.

Calicles minute, 0·5 mm. across, often "imperfectly obvallate." On the lower surface a few distant tubiform calicles, 6 mm. long, closely appressed to the corallum, and in addition a few scattered "cells" (= immersed calicles).

Cœnenchyma spinuloso-asperate, spinules (= tubercles) scarcely 2 mm. long. The spines are trabecular upgrowths covered with long sharp secondary spines.

Neither the description nor the figures of this coral (from Singapore) are easy to understand. Dana's chief figure shows what appears to be an irregular dish-like expanse, through the middle of which branches of another coral project. Around and apposed to these penetrating branches the coral is drawn as having thrown up quite abruptly a few erect but irregular leaves. The centre of the coral is said to have been attached. The smaller figures show the character of the cœnenchyma at the edges of the erect leaves, perhaps of the turned-up edges of the main expanse. The figures also show the polyp (natural size and magnified), with its white "tuberculiform" tentacles. I have not succeeded in identifying any of the tuberculate specimens in the National Collection with this type.

109. **Montipora incognita.** (Pl. XXIV. fig. 1; Pl. XXXIV. fig. 2.)

Description.—Corallum a horizontal, fan-shaped (? circular) expanse, with edges neither turned up nor down, surface even, with slight radial furrows which may result in perforations, the edges of the open slits thus formed being reflexed on to the under surface; 3 to 4 mm. thick

at the growing edge; 1·6 to 2 cm. thick near the centre of attachment. A white, chalky epitheca develops about 10 cm. behind the growing edge. The under surface is covered with drop-like processes of the cœnenchyma, wavy, conical and pointed towards the growing edge.

Calicles conspicuous, averaging less than 1 mm. across, clear, deep fossa opening in the loose reticulum of the cœnenchyma, but often sharply defined by single threads of cœnenchyma, crowded, two often in contact, septa with well defined primaries in regular series; secondaries often only partially represented. On the under surface calicles very sparse, generally associated with one of the conical processes, opening sometimes at its tip, sometimes on its side or at its base.

The cœnenchyma, in section, shows a very thick layer of loose reticulum, streaming towards the growing edge and occupying the whole thickness of the corallum for 3 to 5 cm. from the edge; it is more than 5 mm. thick near the central attached region of the coral. From this perpendicular threads descend to form a rather dense layer resting on the epitheca or else composing the smooth, stony but deeply fissured under surface. This surface is beset with short granular points, round which the thin, white epithecal film first appears as minute discs marked with concentric lines. The trabecular layer is very well developed, nearly 1 cm. deep at the thickest part, the trabeculæ being long, tapering, loosely grouped, of various thicknesses, the cross junctions being, in comparison, very thin and light. The tubercles are tall, thin, erect flames, sometimes like fine bundles of wavy hair. They thickly and evenly cover the whole surface, being tallest and most conspicuous in the slight valleys or round the depressed edges of the open slits. On the reflexed margins of these slits the reticulum is not so loose or open, but is composed of horizontal flakes, so that the corallum is here opaque and white in contrast with the blue-grey of the upper surface. The growing edges of the reflexed margins are swollen into a light, foam-like reticulum, not unlike that of a very delicate bath sponge.

The above account is based upon a single specimen in the National Collection, which shows so many interesting features that it deserves a detailed description. It appears to be part of a sector broken out of some larger flat circular disc, which, however, may have had radial slits running in from the growing edge. Although it is 20 cm. deep, there is no trace of the method of attachment. It had been labelled *M. expansa*, Dana, by Brüggemann, apparently because of the conical cœnenchymatous processes on the under surface, which Dana called "appressed tubiform calicles." On the Museum specimen these processes are more like cœnenchymatous papillæ than protuberant calicles, although it is true that here and there calicles open at their tips. This single doubtful resemblance is hardly enough to identify the two. Under the circumstances, in spite of the fact that nothing whatever is known of the specimen, I prefer to describe it in detail in order to call attention to its structure.

a. Locality not recorded. [Register No. 97. 9. 25. 3.] (Type.)

For a description of the specimens in the Cambridge Museum, from Funafuti, which appear to be related to the above, see the Appendix.

110. Montipora phrygiana.

Madrepora phrygiana, Esper, Forts., ii. (1798) p. 10, pl. lxxxiv.
Non *Montipora phrygiana*, Milne-Edwards and Haime, Ann. d. Sci. Nat., (3°) xvi. (1851) p. 61 (= *M. angulata*).

Description.—Corallum consists of a cluster of narrow leaves, lobate, irregularly twisted and longitudinally folded so as to form a system of ridges and furrows, these latter being equally marked on both upper and lower sides (hence the corallum was probably thin).

The calicles are very scattered but conspicuous, the six prominent and thick septa making the aperture markedly star-shaped. The secondaries irregularly developed.

The most marked peculiarities are presented by the cœnenchymatous tubercles (?). These cover the whole surface and are closely packed; they are granulated and toothed on both sides. They are of many shapes, leaf-like, and either arranged in parallels or at right angles to one another, or else round or oval. These oval tubercles are often arranged in star-like groups of all sizes, consisting of 3, 4, 5 and 6 tubercles, ranged radially either round a central tubercle or else with no central tubercle. This highly complex arrangement of the tubercles covers the whole surface, making it look like embroidery with the edges fringed, hence the name "*gestickte Sternkoralle.*"

The record of this coral, which Esper declared almost surpassed all other corals in its marvellous structure, deserves repetition, even though there is some doubt as to whether it is a Montiporan. Milne-Edwards and Haime assumed that it was a true Montiporan, but identified it with Lamarck's Porites "angulosa" = *angulata* (see p. 63). This identification cannot, however, be accepted. The arrangement of the tubercles in raised star-like groups is a feature on which Esper lay special emphasis; Milne-Edwards and Haime pass over this entirely. Esper declared that the coral came nearest to his *Madrepora contigua*, which appears to have been a *Porites*.

The following characters seem to indicate that the coral must have been a true Montipore: (1) The shape and size of the calicles; (2) the great abundance of the cœnenchyma; (3) the rising of this cœnenchyma into what appear to be tubercles. On the other hand, if this reasoning is correct this must be reckoned as one of the most remarkable of all Montiporan types. In the flat, plate-like character of the tubercles it reminds us of *M. scutata*, in which the scale-like tubercles may be closely packed.

Its locality was unknown to Esper, who adds, however, that it was probably from the East Indian seas.

111. Montipora informis. (Pl. XXVII. fig. 3; Pl. XXXIV. fig. 3.)

Description.—Corallum encrusting, with free, generally drooping edges, 3 to 4 mm. thick, and without supporting epitheca. The upper surface rises into shapeless angular masses, pointed and jagged; these incorporate by encrustation foreign organisms. Other upgrowths are nearly flat, bifrontal laminæ or folds, sloping outwards from the faces of the drooping margins.

Calicles conspicuous, scattered, 1·5 to 2 mm. apart, 0·75 mm. in diameter; deep open fossa. Two cycles of short, rather regular septa, the secondaries smaller than the primaries. The latter spring directly out of the jagged tubercles which surround the calicles, except when the latter are immersed in delicate reticulum; in this case the aperture is clear and round, the septa only appearing some distance below the surface. On the under surface the calicles are smaller, rather more numerous, and generally surrounded with a protuberant cœnenchymatous ring.

The cœnenchyma is a fragile, delicate reticulum, which forms in irregular patches (generally giving rise to slight eminences or ridges) stout distinct trabeculæ joined by very thin junctions. These trabeculæ at such points rise above the surface to form short ragged tubercles, the long delicate points of which may meet and fuse like thin hyphal threads spread over the surface. In the valleys and on the flatter surfaces the reticulum comes to the surface as a delicate open lacework immersing the calicles. In some of the deep valleys the calicles may be protuberant as thin, white, membranous but perforated cylinders visible to the naked eye. The reticulum forms the substance of the coral except where stout trabeculæ have been developed. It is possible with a pocket lens to see down between the trabeculæ, so open and fragile is the cœnenchyma.

There are two specimens of this coral which can, however, be fitted together, the smaller being but a detached, jagged excrescence from the surface of the larger (see Pl. XXVII.). The two together show the luxuriance of the growth. It is worth noting that the tubercles are specially developed on prominences and small branch-like lobes. This same feature is seen also in *M. hispida* and *M. trabeculata*. As in this latter case, this peculiarity accounts for the absence of the axial reticulum from the sections of broken knobs.

The type specimen has encrusted the dead remains of a former growth. This latter appears also to have grown in the same irregular amorphous fashion. There is no trace of any of the preceding dead growth in the axis of the large detached excrescence (*b*); this fact shows how richly the corallum sends up its irregular masses.

a. Murray Island, Torres Straits. 85. 6. 30. 3. (Type.)
b. (Fragment of same specimen).

112. **Montipora hispida.** (Pl. XXVI.; Pl. XXXIV. fig. 4.)

Manopora hispida, Dana, Zoophytes (1848) p. 496, pl. xliv. fig. 5.
Manopora spumosa, Dana (*non* Lamarck), op. cit. p. 495, pl. xliv. fig. 4.
Montipora hispida, Milne-Edwards and Haime, Ann. d. Sci. Nat., (3°) Zool., xvi. (1851) p. 63.
Montipora monticulosa, Studer, Mit. Bern. Nat. For. Ges. (1880) p. 23, figs. 2*a*, 2*b*.

Description.—Corallum typically forms a large circular convex plate supported on the tips of the branches of former growths (or of other corals?). From the central region of the upper surface of this plate confused masses of thick lobes rise up, branching and fusing irregularly. An epitheca appears irregularly on the under surface. Forms (younger?)

without the convex basal plate occur, which are merely creeping down still younger branched forms.

The calicles are star-like and minute (0·75 mm.), very clearly and sharply cut out of the smooth, flake-like lamellæ of the cœnenchyma; the aperture level with the nearly smooth surface and not closely surrounded by tubercles. The primaries reach to the half radius circle; secondaries merely notch the neat, round interseptal loculi between the primaries, making the latter heart-shaped. The calicles on the under surface minute (0·5 mm.), numerous, star-shaped, also cut cleanly out of the thicker and coarser lamellæ of the cœnenchyma.

The cœnenchyma in section of an explanate portion shows a laminate streaming layer, the laminæ having circular holes; the upper thickening layer is very markedly trabecular, the trabeculæ being long and distinct, joined together by horizontal flakes in such a way that the spaces between them are circular in vertical section. The trabeculæ shoot up above the surface into tall tubercles, often thin and flat, with small circular holes through them. These, often bristly looking, tubercles are sometimes unevenly distributed, but are always especially crowded and long on the rising knobs, or on the tips of branches. On the broad flat tops of fused branches they may unite to form broken systems of tall ramparts round the calicles. They usually stand back a little from the calicle margin.

The surface of the interstices between the tubercles, being composed of lamellæ perforated by a few circular holes, is smooth, and where the pores are not numerous, stony-looking.

This species, which is extraordinarily variable, is represented in the National Collection by six specimens, three of which show the typical method of growth with the large convex basal plate. Dana originally gave the name *M. hispida* to the specimens with this plate, while those without it, though from the same locality (Singapore), he called *M. "spumosa."* * Milne-Edwards and Haime first pointed out the probable identity of the two types. An examination and comparison of the specimens, compared with what we know of the habits of the genus, suggests a possible explanation of the two forms. The young coral commences by encrusting the tips of the branched corals down which it may creep, successive growths adding to the thickness of the stock. Under favourable circumstances the lowest fringe of the creeping edge may expand and be successively widened and thickened (one large specimen shows traces of seven encrustations forming the basal disc), until a large, circular, crinoline-like growth depends on all sides, from the top of which the stock proliferates in lobed branches. Stocks thus get heavier and heavier, but as the crinoline expands it finds new supports in other corals. The largest specimen in the collection is 40 cm. in diameter and 20 cm. high, and seems to have rested on a few corroded branches now deeply imbedded in its substance and almost rotten from the action of boring organisms; the under surface either forms pendent drops, or else patches of the cœnenchyma appear protruding through the epitheca, probably for fresh points of attachment.

a and *b* are two large specimens showing the typical development. They are probably

* See Dana's text: under the figure the name, evidently by a printer's error, is "*Squamosa.*"

from Singapore, although unfortunately no locality is recorded. They were correctly identified by Brüggemann.

a, *b*. Locality not recorded. [Register Nos. 44. 6. 10. 10.; 46. 7. 1. 16.]

c is a smaller stock with a thin, rather crumpled crinoline portion, while the branches and lobes are also thinner and rise more erect and parallel, fusing together to form compact columns of different thicknesses, with swollen level plateaux on the tops which may fuse together. Here the tubercles show a tendency to run together to form ridges and crests, and also ridges up the sides of the lobes. This description agrees with that given by Dana for his *M. spumosa*, but there is not sufficient ground for separating it from *M. hispida*. Such a specimen is apparently the *M. monticulosa* of Studer, also from Singapore.

c. Singapore. Marquis of Northampton. 39. 12. 7. 1.

d a large branching stock, the branches being massive, and cylindrical except that they are covered with knobs; without any expanding basal portion; the lower edge of the corallum is merely encrusting the thick dead stem of a similar previous growth; the tubercles are rather more cylindrical than in *a* and *b*.

d, *e*. Straits of Malacca. Government of Straits Settlements. 83. 11. 8. 8.

A fragment broken from the top of a thick lobe.

f. Locality not recorded. [Register No. 43. 3. 6. 117.]

113. Montipora tuberosa.*

Porites foliosa (partim), Ehrenberg (*non* Pallas), Korallenthiere (1834) p. 117.
Manopora foliosa, Dana, Zooph. (1848) p. 497.
Montipora Ehrenbergii, Verrill, in Dana's 'Corals and Coral Islands' (1875) p. 333.
Montipora tuberosa, Klunzinger, Korallenthiere, ii. (1879) p. 32, pl. vi. 6, pl. v. 8, pl. x. 3.

Description.—Corallum explanate, slightly concave owing to the turning up of the edge. Edge 5 to 7 mm. Surface rises into knobs and lobes often 5 to 7 cm. high and 3 cm. thick; these frequently give rise to secondary lobes.

Calicles numerous and conspicuous, with septa irregularly developed, on the under surface surrounded by solid rings.

Cœnenchyma covered with tubercles pointed and thin, 1 to 2 mm. high, specially crowded on the tubers and lobes.

This description is founded on Klunzinger's text and photographs; it refers to one of Ehrenberg's specimens, 25 cm. in diameter, and labelled by him with others as *Porites foliosa*,

* Verrill's renaming of Ehrenberg's *foliosa* ought, perhaps, on grounds of priority, to have preference.

"Lamarck" (= Pallas). It is said to be very similar to Dana's *M. hispida*, with which it might be akin. Dr. Klunzinger, following Dana, points out the difference between the concave explanate portion and the peculiar convex form of the basal plate of *M. hispida*, from the summit of which the branching lobes arise. I am inclined to think that this difference is very important; the dish with turned up edges would appear to signify that the chief upward growth of the stock was typically round the edges, while in *M. hispida* the chief growth is in the towering lobes, the explanate portion being a secondary production due to downward streaming of the living layer.

On my suggested identification of this type with the earliest recorded Montipore, the *Madrepora monasteriata* of Forskål, see below under the next heading.

114. Montipora monasteriata.

Madrepora monasteriata, Forskål, Desc. Anim. (1775) p. 133.
Madrepora monostriata, Linn., ed. 13 (1788) p. 3773.
Non *Montipora monasteriata*, Milne-Edwards and Haime, Cor., iii. (1860) p. 208.
Non *Montipora monasteriata*, Klunzinger, Kor. (1879) p. 34, Taf. vi. 2, v. 9, x. 6.

Description.—Corallum unknown. Calicles crowded, separated by the tubercles.

Cœnenchyma rises into lanceolate, tongue-like tubercles, the size of mustard seeds, but erect, flattened, and about twice as long as the diameter of a calicle; four to five around each calicle, individual tubercles being common to adjacent calicles. The coral, though reticulate and spongy, is yet very rough. Red Sea.

This is the essence of Forskål's description of the earliest recorded species of Montipore. Nothing further is known of it than that which we can gather from this account. It is, however, quite certain that Forskål's specimen belonged to the tuberculate group: lanceolate tongues the size of mustard seeds, grouped in fours or fives round the calicles, leave little doubt as to this. Recognising this, we are at once enabled to form a judgment of the synonymy. Milne-Edwards and Haime, for instance, would make it synonymous with the *spumosa* of Lamarck, which was founded on Knorr's figure (see p. 71), and, omitting all mention of the essential feature in Forskål's description, viz. the lanceolate tongues, wrote "les saillies cœnenchymateuses sont en général grosses, peu saillantes et ordinairement peu nombreuses." This description clearly refers to Knorr's figure.

Still earlier Ehrenberg had suggested with a query its identification with his own *Porites* (= *Montipora*) *circumvallata*. This suggestion was adopted by Milne-Edwards and Haime in their synonymy, and more recently still by Klunzinger, who claimed that the essential feature of Forskål's type is shown in Ehrenberg's specimen, which he has redescribed and photographed. On carefully examining these descriptions and figures, it seems to me that *M. circumvallata* was not a tuberculate Montipore at all. The eminences of the cœnenchyma are "very blunt" (the opposite of lanceolate tongues), "broad, leaf- or scale-like," and often forming "protruding under lips to the calicles." On the upper portions of the stock these may surround the calicles, but in such a way that the individual papillæ are still recognisable. This description agrees well with the photographs; both description and photographs seem to

me to be quite irreconcilable with a specimen of which the most striking features were the erect, flattened, lanceolate tongues, "four or five round each calicle."

Again, the original description of the tubercles appears to agree best with those of *M. hispida*. Montipores closely resembling *hispida* are known from the Red Sea, e.g. *M. tuberosa*, Klunzinger. Further, among the Montipores of the Paris Museum there are a number of specimens from the Red Sea closely resembling *M. hispida*, some indeed with flat lanceolate tongues much more pronounced than in *M. hispida*. These beautiful corals show remarkable variations and may perhaps not all be specifically related. They have been labelled *M. monasteriata*, Forskål. Some of them shade into another group which has been identified with *M. tuberosa* of Dr. Klunzinger.

It is among these that I think we might find the nearest approach to Forskål's type.

115. **Montipora friabilis.** (Pl. XXIV. fig. 2; Pl. XXXIV. fig. 5.)

Description.—The corallum is formed of a cluster of small ladle-shaped folia with smooth regular outer surfaces, each from 4 to 5 cm. in diameter, about 2 cm. deep, and with growing edges from 4 to 5 mm. in thickness. These folia are clustered quite irregularly, one growing out of the side of, or on the top of the other, in which latter case hollow chambers arise in which the coral polyps seemed able to live. In the centre of the corallum the folia may be distorted, the edges being irregularly bent; but the tendency to put out ear- or ladle-shaped outgrowths persists. The upper edges of the symmetrical ladles tend to curve over inwards to form a thick irregular rim. From the rounded upper outer surface of this rim a fresh foliate outgrowth may start. The smooth rounded outer surfaces of the ladles are entirely free from epitheca.

The calicles range from 0·75 mm. and less; they are very irregularly distributed. Aperture petaloid, very seldom sharply outlined all round. Septa in one cycle (often part of a second) reach nearly to the half radius circle as very thin, hairy, glassy filaments. Double calicles occur with a columella-like dividing process. On the outer surfaces of the folia the calicles are crowded; they are slightly protuberant, and in the basal portions where the tissue is denser, are surrounded by thick solid rings which are seldom quite complete and from which thick septa project.

Cœnenchyma consists of a lamellate reticulum extremely light and friable at the edges and on the upper surface. The streaming layer is very marked and forms the whole thickness of the growing edges. In forming the lower surface it tends to be arranged in definite parallel lamellæ running out radially perpendicular to the surface and at even distances apart. This gives the surface in patches a finely striated appearance. The upper surface is everywhere covered with erect, tall, thin, flat flakes, very delicate and friable, and often perforated to such an extent as to leave little more than a few threads or glassy hairs. These make the surface of the bleached skeleton look like cotton-wool. In thicker and older portions of the corallum, on ridges, &c., these may become denser and more typically tuberculate; or again,

they may meet together to form small groups of thin foveolate ramparts which generally rise up above the surrounding level.

This interesting coral from some unknown locality was named by Brüggemann "*Montipora foliosa*." The above description does not confirm this identification. The small, comparatively thick, ladle-shaped folia, clustered irregularly, with no appearance of spiral twisting, would alone separate it from all the other foliate Montipores, while in its surface markings it stands quite alone. Where the tubercles are formed they most resemble those of *M. hispida*. The extreme delicacy of the reticulum, and the friability of the specimen, especially of the thick edges, is also peculiar. The figure (Pl. XXXIV. fig. 5) includes none of the tubercles.

a. Locality not recorded. [Register No. 47. 1. 19. 20.] (Type.)

116. **Montipora aspera.**

Manopora crista-galli, Dana (*non* Ehrenberg), Zooph. (1848) p. 494, pl. xlvi. fig. 1.
Montipora aspera, Verrill, in Dana's Corals and Coral Reefs (1875) p. 333.

Description.—Corallum "erect-subcespitose inciso-lobate," compressed, angular and alate, lobes often cultrate, crests without calicles, stocks often a foot in height and same in breadth.

Calicles very distinctly six-rayed, 0·6 mm. in diameter, generally nearly naked, but occasionally with a few minute "spinuliform papillæ" about them.

Cœnenchyma very fragile, "spinuloso-asperate"; the "spinuliform papillæ" sometimes run into thin longitudinal ridges; under a lens the surface is neatly "laciniate-porous," or consists of mossy points about the pores.

The above is constructed from Dana's description of a large Montipore from Singapore. The figures unfortunately do not help much in diagnosing the type. The spinuliform papillæ are probably tubercles in the restricted sense in which that term is here used. We thus have a fragile tuberculate montipore mounting upwards, hardly branching, the upward growing corallum dividing up and fusing again irregularly: the angular compressed wings formed in this way seem to be a special character of the type. There is no specimen in the National Collection which answers to this description. . .

Its locality, Singapore, suggests its affinity with *M. hispida*, from which, however, it differs in manner of growth.

117. **Montipora fragilis.** (Pl. XXXIV. fig. 6.)

Montipora fragilis, Quelch, Chal. Rep. Reef Corals (1886) p. 171, pl. viii. figs. 1, 1*a*, 1*b*.

Description.—Corallum forms long slender upright stems some 9 to 10 cm. in height, irregular, flattened and branching, the branches running up close to the stem.

The calicles are small, 0·4 mm., rather scattered, 1 mm. and more apart, the aperture irregular, sharply cut out from the thin flakes of the cœnenchyma; six short, petaloid, interseptal loculi, with occasional indication of a septum of the second cycle.

Cœnenchyma shows in section an open laminate streaming layer surrounded by a thin radial cortical layer in which very short stout trabeculæ are developed. These project above the surface on the thicker and older parts of the stems as stout, solid, not very symmetrical tubercles, 1 mm. or less in height, rising from an almost solid interstice. The younger flattened tops of the branches are, on the contrary, entirely composed of the streaming layer, which seems to fray out and become ragged. The corallum is here very porous and friable, and covered with thin spiked ridges and projecting flakes with jagged edges. In the transition zone between these growing tops and the older parts, the tubercles are not unlike those of *M. hispida*, being in many cases perforated. (Pl. XXXIV. fig. 6.)

In describing this type Mr. Quelch stated that it came near *M. palmata*. This is true in the general character of the calicles and method of growth. On the other hand, this is a typical tuberculate Montipore, whereas *M. palmata* belongs to the foveolate group.

a, *b*, *c*. Banda. H.M.S. 'Challenger.' 86. 12. 9. 252. (Types.)

b. Tubercles running into or combined with ridges.

118. Montipora rus.

Madrepora rus, Forskål, Desc. Anim. (1775) p. 135.
Porites rus, de Blainville, Dict. Sci. Nat. lx. (1830) p. 360.
Non *Montipora rus*, Milne-Edwards and Haime, Ann. Sci. Nat., xvi. (1851) p. 58.
Non *Montipora rus*, Klunzinger, Kor., pt. ii. (1879) p. 36, pl. vi. 9; v. 5; x. 8.

Description.—Corallum explanate, foliate.

Calicles somewhat obscure, round, about the size of a mustard seed.

Cœnenchyma rises into tubercles which run here and there into keels, undulating and denticulate. Tubercles crowded on the higher portions of the corallum.

Unfortunately Forskål's original description says nothing about the shape of the corallum, and we are left to gather from the denticulate keels with the subtile, spongy condition of the surface papillæ that the specimen was of the tuberculate type, with the tubercles running together to form undulating and denticulate "keels."

Milne-Edwards and Haime, and later, Dr. Klunzinger, interpreted this specimen to have been papillate, and the latter author thought it was the same as Ehrenberg's *mæandrina* (p. 100); but this latter coral, with its irregular rounded papillæ, does not form ridges which could properly be called "keels" (carinæ). Besides, there are no parts that are so subtilely "papilloso-spongioso" as to appear "covered with a spider's web," an expression which is certainly not easy to understand under any supposition.

All that we are justified in suggesting, then, is that Forskål's original specimen was a tuberculate Montipore from the Red Sea, and near *foliosa*. And further, as he does not mention keels in his first enumeration of the characters, but only in his fuller description, these keels were probably not as striking as they usually are in *M. foliosa* itself.

In the National Collection there is only one explanate tuberculate Montipore showing traces of keel formation from the Red Sea. It has been labelled *M. foliosa* by Brüggemann. It is a flat, somewhat wrinkled leaf, forming slight keels all round the edges. The tubercles are crowded, minute, and somewhat uniform in shape and appearance, and give the whole surface a curious indefinite appearance, but there is nothing suggesting a spider's web. But of course it is impossible to lay much stress on such points. The main facts connecting this specimen with *M. rus* are these—both appear to be tubercular carinate Montipores, and both are from the Red Sea.

A further description of the Museum specimen here provisionally placed under this heading, will facilitate either the refutation or the confirmation of this new interpretation of Forskål's type.

Description.—Corallum a wrinkled uneven leaf 11 cm. deep, the under surface free of epitheca except in minute patches, but thickly covered with irregular ridges, or keels, or papillæ, on the tips or sides of which calicles may open. Growing edge 2 to 2·5 mm. thick.

The calicles are conspicuous owing to the close ring of tubercles round each, obscuring the septal arrangement, which is deep down; only where the tips of the tubercles are uniting to form a fresh surface are the septa seen at the surface, six in number, stout, irregular. The calicles are, as a rule, crowded concentrically but more distant radially. On the under surface the calicles are smaller, with hardly any septal systems beyond a few irregular points from the stout surface granules of the cœnenchyma.

The cœnenchyma consists in section of an open laminate reticulum, the clean cut edges of the laminæ coming to the surface at the growing edge as an elegant line pattern. Upon this rests a very well developed trabecular layer, short, thin, definite trabeculæ crowded together rising up into the tubercles, and with hardly any very apparent junctions binding them together. The tubercles are uniform in size and height. Round the growing edge the laminate reticulum rises up into keels, from which later tubercles arise, making the keels denticulate. The keels in this specimen are soon lost among the crowded tubercles of the surface, which fill up all interstices so that the real interstitial surface is no more visible.

While classing this specimen here on account of its suggested identity with the keel-forming *M. monasteriata*, it must be admitted that its true place would be nearer *M. granulata* on account of the uniformity and grain-like aspect of the tubercles. The keel formation round the edge is due entirely to the laminate streaming layer, cf. the descriptions of *M. foliosa*, p. 157.

a. Red Sea. [Register No. 40. 5. 7. 6.]

119. **Montipora crassi-tuberculata.** (Pl. XXV. fig. 1; Pl. XXXIV. fig. 7.)

Description.—Corallum explanate as a massive heavy slab, much crumpled. The method of attachment unknown. Hardly 2 mm. thick at the free growing edge, but thickens very rapidly to 1 or 1·5 cm. The upper surface is remarkable because of the diversity of its

texture, and the lower surface very irregular, due to protrusions of living coral encrusting masses of worm-tubes and Balanids. The epitheca is developed in patches but is soon corroded.

Calicles densely crowded in the broad valleys, more sparse on the eminences, average 1 mm. Two cycles of fine, very distinct septa, reaching to about the half radius circle; directives here and there pronounced. The more crowded calicles are separated from one another by thin partitions of a fine spiky reticulum; here and there a stray tubercle, short and stout, manages to rise up between. On the eminences the calicles are often carried up by encircling groups of tubercles. Where the corallum is beginning to die down, the reticulum, including septa, becomes denser, tending to close and diminish the size of the polyp cavities, and thus also increase their distances apart. The calicles on the under surface show the same variation, but they are never so densely crowded as on the upper surface.

Cœnenchyma. The laminate reticular layer, appearing at the surface of the growing edge, forms a finely striated border, the striæ being the thin cœnenchymatous laminæ standing up edgewise and parallel with one another (cf. *M. striata*, *M. australiensis*, from the same locality). A short distance from the edge this layer becomes almost solid, and on it rests a thick but very irregularly developed trabecular layer. In the smooth valleys crowded with calicles the trabeculæ are distinct but not very thick, but on the eminences they may attain to an enormous size, being occasionally a millimetre in thickness. These trabeculæ rise very irregularly above the surface, forming conspicuous tubercles of all sizes and shapes, cylindrical, flattened, triradiate, but all alike round-topped, swollen, bushy but compact, and with clear outlines. They are arranged at all angles with one another and show no definable association with calicles, round which, however, by fusing together in twos and threes to form plates, they make tall but discontinuous ramparts. When the tubercles are very crowded and fused together, they tend to produce the proliferation of the surface which characterises *M. prolifera*. Where the surface is dying down the trabeculæ thicken and their tips become smooth and flat and all on the same level; the gradual filling up of the spaces between soon makes the corallum a solid mass.

Tubercles also appear on the under surface, each tubercle being distinct, deep openings into the cœnenchyma being visible between them. Elsewhere the under surface is formed by the trabeculæ all ending in distinct flat but frosted grains.

There is only one specimen of this beautiful coral. It is more than 20 cm. deep, and though only 1·5 cm. thick stands 5 cm. high, owing to the undergrowth mentioned above. Both surfaces are beset with Balanids, all of which are grown over, their apertures, however, remaining open. The specimen is peculiar on account of the size and variety of its tubercles with their solid trabeculæ and cores. Here and there where the rich red-brown granulation or frosting which coats the tubercles has been rubbed off, the tubercles stand up like groups of opaque solid crystals.

a. Houtman's Abrolhos, West Australia. Coll. Saville-Kent. (Type.)

120. **Montipora amplectens.** (Pl. XXXIV. fig. 8.)

Description.—Corallum encrusts large stones as a thin sheet 2 to 3 mm. thick, creeping round up the sides and meeting over the top, in close contact, and covering over other encrusting organisms.

Calicles numerous and crowded at irregular distances, about 0·75 mm. diameter, conspicuous, with rather regular, almost laminate primaries not reaching to the half radius circle, secondaries only irregularly and partially developed. Where the corallum encrusts the under sides of the stone the calicles are much further apart and more regular, and have thicker, more regula septa.

Cœnenchyma shows in sections of the portions creeping up the sides of the stone a well developed, open, reticular streaming layer resting upon the epitheca; this rises, from 2 to 3 cm. from the growing edges, into small, thin, feathery plates and ridges, which form a kind of irregular network, with the calicles in the meshes. These plates gradually change into tubercles, which are thickly crowded, very irregular in height, and so finely feathery that the surface of the corallum looks as if covered with small balls of wool; the tubercles do not rise immediately round the margins of the calicles, and are very seldom arranged in rings. Groups here and there, in irregular association with one or more calicles, fuse and rise into small knobs or crests hardly 2 mm. high. The section of the lower portion of the corallum shows (1) a solid layer nearly 1 mm. thick resting upon the epitheca; (2) a very thin vestige of the streaming layer; and (3) an almost solid layer of thick trabeculæ. The tubercles hardly rise above the surface, but are compact and crowded and make the surface almost solid, the distances between the calicles being much greater.

There is only one specimen of this coral. It completely envelops the pointed end of a nearly fusiform piece of rock. There are no indications of any previous growths. The method of growth is peculiar, the corallum growing upon the sides and bending smoothly round over on to the uppermost surface, covering the stone with a thin, closely fitting single layer of corallum. More specimens, of course, are needed to ascertain for certain whether this is typical or merely accidental.

The thin streaming layer between two nearly solid layers, as seen in the section of the lower parts of the corallum, recall the condition in *M. bilaminata*, only in that case the corallum was thin and explanate, and the density was needed for strength; in the present case the lower parts of the corallum show the same tendency to solidify which has already been frequently noticed and assumed to be due to the downward streaming of fluids under the action of gravitation.

a. China, probably south (with *Madrepore* ? sp.).	Chinese Commissioners, Fisheries Exhibition, 1883.	(Type.)

121. Montipora patula.

Montipora patula, Verrill (*non* Quelch), Proc. Essex Inst., vi. (1868) p. 87 (v. *M. peltiformis*, p. 128).

Description.—Corallum thin (4 mm. at 2·5 cm., 8 mm. at 7·5 cm. from edge), attached and encrusting at centre, edges free and explanate, projecting some 10 cm.

The calicles are minute 0·75 mm. in diameter, crowded, with six septa reaching to about the half radius circle. In the larger and older calicles in the central part of the stock two cycles appear, the secondaries being very narrow.

Cœnenchyma "very porous," thickly covered with small, unequal, prominent, round-topped tubercles, which have an open spongiform texture, their surfaces covered with rough projections. Sometimes these are less developed, and are then like clusters of spongy trabeculæ which project all over the surface and are lacerately divided. Four or five of the larger tubercles usually surround each calicle. The largest tubercles are scarcely 0·5 mm. in diameter and 1·0 mm. in height. Round the edges they tend to form radiating ridges.

This description evidently refers to a tuberculate Montiporan, the radiating ridges round the edge appearing to suggest affinity with the next type. The original was from the Hawaiian Islands and is preserved in the Yale College Museum.

122. Montipora effusa. (Pl. XXV. fig. 2; Pl. XXVII. fig. 1.)

Manopora effusa, Dana, Zoophytes (1848) p. 500, pl. xlvi. fig. 4.
Montipora effusa, Milne-Edwards and Haime, Ann. d. Sci. Naturelles, (3°) xvi. (1851) p. 64.
Non *Montipora effusa*, Quelch, Chall. Rep., Reef Corals (1886) p. 178 (v. *M. Challengeri*, p. 121).

Description.—Corallum with thin, free, explanate initial growth, sending up tortuous cylindrical processes which branch and fuse into shapeless masses, the processes and branches encrusting one or more worm tubes, and hence curved in different directions. The explanate portion may die away and the confused tangle of branches continue, or on the other hand the whole growth may remain explanate, hardly any worm-tubes being present. The branches when free are fairly uniform in thickness on one and the same stock, but vary from 3 mm. to 2 cm. The explanate portions of the specimens with thicker branches are thicker than those with thin branches.

Calicles star-shaped, immersed, minute, 0·6 mm. (still smaller on specimens with thin branches), with six well-developed septa separated by clear, round or petaloid interseptal loculi, except when the rudiments of a second cycle appear. Evenly distributed about 2 mm. apart, always minute where the layer covering the worm-tube is thin. On the under surface of the explanate portions, when not covered with epitheca, calicles may appear either

immersed or else with thin, irregular, warty margins, formed by minute, solid, granular, cœnenchymatous swellings (tubercles) of different sizes.

A section of one of the thicker branches shows a solid layer in contact with the worm-tube or tubes, surrounded by a dense reticular layer and a trabecular layer (not developed in the thinner branches). The trabeculæ are usually very stout and solid, and project above the cœnenchyma as pronounced cylindrical granular or bushy tubercles, so large that they might be mistaken for papillæ. Without being regularly arranged round the calicles, they are often taller near the polyp cavities. Round the edges of the explanate portion the tubercles give place to radiating ridges, and on the branches, especially near their tips, the tubercles fuse into plates and ridges bent at all angles to one another, sometimes triradiate, sometimes thin and even, at others swollen along their upper edges. Scattered among these plates are simple cylindrical tubercles of all sizes, but mostly mere granular knobs.

The specimen of *M. effusa* from Tahiti figured by Dana was a flat explanate growth with slightly turned-up edges and one plate growing over another, and from its surface bent branches arose abruptly as encrustations of worm-tubes. The smaller drawing (4*a*) also clearly shows the surface to have been covered with tubercles; while in the larger drawing the fusions of these into bent plates and ridges is faintly but, it seems to me, unmistakably indicated. The thickness of the branches is given as 16 mm.

There are in all ten specimens in the National Collection which I place under this heading. Of these, four consist essentially of bent and fused processes encrusting worm-tubes, while four are almost purely explanate, with but very poor and feebly developed processes due to worm-tubes. In all ten cases the tubercles are pronounced, and fuse to form ridges and bent angular plates thickly covering the whole or parts of the surface. These specimens, however, differ from one another so strikingly in general appearance, that it was only after a long time, when revising and re-revising this attempted classification, that I eventually brought myself to group them provisionally together. It is indeed worth expressing a doubt whether, in view of the differences in the calicles and in the characters of the tubercles, this is a species at all, and not rather an array of tuberculate Montipores accidentally but somewhat similarly distorted by worm-tubes.

The commensal worm-tubes which seem necessary to give this coral its typical branched character are about 1 mm. in diameter, and occur singly or in groups. In one specimen (*c*) I have counted thirteen in the section of a broken branch. In specimen *b*, whereas six tubes are seen in a section of two fused cylinders, more than twenty-five open at the tips of their branches. It appears, therefore, as if the worm-tubes must branch within the corallum. Here and there a tube in the centre of a branch does not open at the tip, the worm having either died or been killed by the more rapid growth of the cœnenchyma encrusting it.

a. The largest specimen from the Persian Gulf is a confused tangle of thin cylindrical branches, each with a different curve (Pl. XXVII). Owing to the thinness of the cœnenchyma encrusting the worm-tube or tubes, the trabeculæ are only here and there slightly developed, but the ridges and tubercles which, if the branches thickened, would become (when immersed by the thickening cœnenchyma) the trabeculæ, show all the typical shapes. A great number of sponges shelter among the interstices of the interlacing branches. The original explanate portion has decayed away, but here and there fresh attempts to form explanate platforms can be seen. Dark fawn colour.

b. A singularly beautiful specimen from Diego Garcia (Pl. XXV.) consists of a tangled mass of thick branches (2 cm.) with very stout trabeculæ, and showing all the typical trabecular formations. Explanate portions developed here and there. Colour, a light fawn tinged with rose-red (cf. specimen *g*).

c. A corroded specimen from Aden is especially interesting, because it shows a flat explanate growth 17 cm. long and 8 to 9 broad. From the centre of this, columns arise from thin bases and swell out into great nodulated masses 7 to 8 cm. high, which fuse together; worm-tubes opening irregularly over the surface. This is a departure from the type, but the essential characters agree with those described for *a* and *b*.

d. In another specimen from Aden the tips of many of the fused branches show a great proliferation of the axial reticulum. This, in many cases at least, succeeds in burying the worm-tube. Worm-tubes in all stages of disappearance, beneath the white, woolly-looking papillæ which cap so many of the fused branches, can be found. The last stage of closing might be mistaken for a calicle, viz. a deep funnel-shaped hole set all round with echinulæ not unlike septa. The explanate encrusting portions are fragmentary and irregular, one is encrusting and apparently destroying a large Mussa. The specimen owes perhaps some of its irregularity to the swarms of Balanids which have settled upon it. The calicles are much larger than in *c*, and the tubercles more light and reticulate. Some of these differences may be due to the corrosion which *c* appears to have undergone before collection.

e, f. Two almost purely horizontal explanate growths, about 2 mm. thick at the growing edge, and 6 to 8 mm. in older parts, with well developed epitheca extending to within 2 to 3 cm. of the growing edge, which is slightly turned up as in Dana's type. These specimens differ greatly in external appearance, both from one another and from the foregoing. Yet they are united together by being both tuberculate, in having very similar textures in section, and the same method of growth. And, finally, they are united with the foregoing specimens by the fact that here and there worm-tubes commence to form short branches (although not yet reaching more than 1 cm. high), and on these the tubercles show the usual tendency to form plates.

g. There is, further, a specimen which differs in appearance again from any of the above. It is explanate, much distorted by Balanids and sediment, and is suffused with a rose-pink colour, and the growing edge is closely followed by the epitheca. The alliance with the above, however, is shown by its cœnenchymatous specialisation being the same. The tubercles form plates arranged at angles with one another, and there is a tendency to form branches encrusting small worm-tubes, the cœnenchymatous plates being especially rich on elevations, at least as soon as they reach a certain thickness. In this specimen the few incipient branches round worm-tubes are still too thin to show the plate formation, but this is seen on certain upgrowths from the surface and round a drooping lower edge. This specimen may well be the explanate form of such a specimen as that above described from Diego Garcia (*b*).

h, i, j. Lastly, there are three broken fragments which have all the appearance of being portions of the explanate bases of a specimen like those described above. One (*h*) was labelled *Montipora scabricula*, Dana, but, in its cœnenchymatous specialisations it agrees essentially with the type, and from its close resemblance to *c* must, I should think, have come from Aden.

All these very different looking specimens are united by the following characters: (1) initial or at least partial explanate growth; (2) tuberculate with radial ridges round the

edges; (3) a tendency to form tufts (open or close) of cylindrical branches encrusting the tubes of commensal worms; (4) the tubercles form plates at all angles with one another, especially upon the branches due to the commensal worms. I feel, therefore, justified in making this provisional group under the specific name *effusa*, Dana's species having shown all the above characters. That the grouping is purely provisional, the differences in the calicles and in the tubercles themselves abundantly prove.

a. Persian Gulf.	A. S. G. Jayakar, Esq.	92. 1. 13. 7.
b. Diego Garcia.	G. C. Bourne, Esq.	91. 4. 9. 43.
c. Aden.	Major Yerbury.	87. 12. 11. 16.
d. Aden.	„ „	87. 12. 11. 11.
e, f. Rocky Island, Great Barrier Reef.	Coll. Saville-Kent.	92. 12. 1. 261, 264.
g. Palm Islands, Great Barrier Reef.	„ „	92. 12. 1. 6.
h. Locality not recorded.	?	
i. Aden.	Major Yerbury.	87. 12. 11. 13.
? *j*. Tongatabu.	J. J. Lister, Esq.	

123. Montipora frondens.

Description.—Corallum, complete form unknown, free-growing edges divided into distinct lobes, which curve upwards, the lateral edges of one lobe may overlap the adjoining. These lobes are unsupported by any epitheca, and thick, 2 to 3 mm. at the outermost edge and rapidly thickening; older and more central region being 3 cm. thick at 5 cm. distance from the outermost edges of the lobes. The thickening portion is in tiers, showing layers of different growths often separated by deposits of sediment. From this central region thick irregular knobbed processes rise as high as 3·5 cm.

Calicles deep, not conspicuous, 0·75 mm., very irregularly distributed, scattered or closely crowded. Primaries reach beyond the half radius circle; indications of secondaries. One directive often specially conspicuous. When the calicles are surrounded by tubercles the septa begin to appear on the sides of these latter, the directive septa being the highest and best developed. The margin is not sharply defined, the interseptal loculi being open to the deep interstitial fissures. On the under surface, minute star-like calicles open in the coarse flaky reticulum, like small irregular punctures in the surface. They are largest and most conspicuous near the growing edges.

The cœnenchyma shows the typical streaming layer, expanding upwards and downwards into glassy threads. Towards the under surface these are often extremely fine, but are joined by thick and solid junctions. The reticulum of the upper layer is coarse, and its vertical elements are irregularly thickened and nodulated but hardly differentiated into trabeculæ. On the surface these more vertical threads may rise up as tubercles arranged in nearly regular rings round the calicles, the interstices being concavely depressed, and consisting of a nearly

smooth system of plates separated by deep gyrating fissures; above this surface the tips of the threads just appear as low tubercles. The tubercles are bushy but have fairly sharp outlines to the naked eye. Here and there they fuse together to form tall, thin, flat and toothed plates which, when the calicles are crowded, may form a delicate raised tracery surrounding the apertures as direct continuations of their walls. Towards the growing edge, where the calicles slope outwards, similar plates, developed out of the streaming layer, are found in all stages of development, forming angular hoods over the raised edges of the aperture. Where plates are formed, tubercles appear irregularly in the interstitial spaces. Only in the thickest parts of the corallum does the section show the formation of trabeculæ.

The sole specimen is a fragment which appears to have grown out from the side of some object as a few lobate upwardly curving fronds with deep incisions between; the fronds, though joined below, overlap one another. While the earlier produced fronds appear to die down, becoming the receptacle for sediment, the outer edge produces fresh fronds. From this living edge, the coral grows backwards again over the sediment. Three different layers of growth can be seen in the thickest parts with sediment between them, and further fresh sediment has fallen upon and been partly incorporated in the uppermost layer. The rising of the cœnenchyma to cover over the sediment suggests that this may be the stimulus for the formation of the tall knobs and processes.

It is obvious that while this is to all appearances the correct explanation of the growth of this individual specimen, the element of accident is too largely involved for it to be safe to regard it as a good species. Lateral growths by means of distinct lobate fronds may, however, well be regarded as typical.

a. Palm Island, Great Barrier Reef. Coll. Saville-Kent. (Type.)

124. **Montipora trabeculata.** (Pl. XXVII. fig. 2; Pl. XXXIV. fig. 9.)

Description.—Corallum sends up compact ridges or tufts of nodulated processes, with level tops ending nearly in the same horizontal plane; dies away below, the living zone being some 8 cm. deep. The lower edges, creeping down over the old stock, may turn outwards to form short, thick, horizontal, free, tongue-like processes.

The calicles in the lower parts of the colony are very small (0·3 mm.), inconspicuous and scattered. They increase to double that size in the upper portions; here they are deep, with six well-developed primaries and frequently small secondaries; with the exception of the two directives the septa are thin and delicate, and hence leave the aperture fairly open and conspicuous.

Cœnenchyma. While the typical reticular layer is present at the encrusting edges, it is but very feebly and irregularly developed in sections of branching processes, the whole section being trabecular without the usual axial strand. The irregular portions of the trabeculæ fill up the centre, while the more regularly radiating portions form the cortex,

these are long, stout, closely packed, and joined together only by very slender threads. The great majority of these trabeculæ rise above the surface as solid, symmetrical, globular or oval, and delicately frosted tubercles, between which one can see down into the depths of the cœnenchyma owing to the slight development of the junctions. The tubercles are tallest on the eminences, and here take the lead in forming the branches, hence the absence of the typical axial reticulum. On the continuous flat tops of the processes forming the tuft the tuberculate character is lost, and the surface is formed by a fine system of reticulate crests deeply cut into by valleys and pits in which the calicles are sunk. This change in the character of the surface is reached gradually by the change of the tubercles into ridges, which become more and more reticular as the summit is reached.

The single specimen of which the above is a description is unique among the Montiporans in the National Collection in the character of its cœnenchyma. The crowding of the tubercles, their usually perfect symmetry and delicate frosting, their leading in the formation of branches, the consequent absence of an axial reticulum, are points which deserve special notice.

There is, unfortunately, but one fairly complete tuft with two long, narrow, basal surfaces of fracture, which suggest that the whole tuft is due to the proliferation of a ridge, the greater part of which, however, was probably dead and corroded.

a. Townsville, Great Barrier Reef. Coll. Saville-Kent. (Type.)

125. **Montipora ellisi.** (Pl. XXVIII. fig. 2; Pl. XXXIV. fig. 10.)

Description.—Corallum dish-shaped, concave, with steeply turned up edges, thick and crumpled. From both the inner and outer faces of these edges, and from irregularities in the surface of the corallum, the cœnenchyma towers up to form fused masses of spikes covered with ridges and crests. These all rise to about the same height, 5 cm. from the base of the dish. Epitheca only very partially developed.

Calicles about 0·75 mm. in diameter, conspicuous, uniformly distributed from 1 to 1·5 mm. apart. Six thin prominent septa reaching to about the half radius circle; one or two directives. Secondaries just indicated. A conspicuous columella present in most of the calicles on the thinner portions of the dish; not regularly developed in the calicles on the excrescences. On the under surface the calicles have the same characters but are smaller.

The cœnenchyma has a thick layer of delicate laminate streaming reticulum in the explanate portions, solidifying ventrally in the base of the dish, but dorsally changing into trabeculæ, stout, distinct, and bound together by a thin light reticulum. On the outer faces of the curved-up edges of the dish, short, much stouter trabeculæ are also formed. The trabeculæ give rise all over the corallum to tubercles, varying greatly in size, of uniform appearance, solid, closely packed yet distinct, separated by narrow fissures which run straight down between the trabeculæ. These tubercles thus form the whole surface of the coral;

there is no level interstitial surface between them. They are taller, stouter, and more feathery on eminences or on the sides of upgrowths. On the under sides of the coral the tubercles are stouter, smoother, more solid and compact. Towards and on the tops of the crests and ridges the tubercles are replaced by undifferentiated cœnenchyma of the reticular streaming layer, which froths up into spikes and ridges with deep narrow valleys and holes in which, seen under a lens, calicles open; this foaming reticulum is formed of fine plates richly perforated with round pores. At the creeping edges of fresh explanate growths the reticulum is delicate and foam-like.

The single specimen of this type was originally named by Brüggemann "*M. stylosa*, Ehrenberg." It, however, bears no resemblance to the photographs of that type given by Dr. Klunzinger.

The proliferation of the cœnenchyma is singularly beautiful. The whole surface is formed by a mosaic of distinct tubercles separated by deep fissures; they are flat and plate-like on the lower, more solid parts of the under surface, but round, smooth, and solid or bushy, on all the rest of the surface. Further, the change of the tubercles into ridges and tall spike-like crests all pointing upwards are features deserving special attention; the crests being softer looking and rounder than are the somewhat similar developments on *M. foliosa*.

The only other Montipore which I have seen apparently resembling it is a conical cup open at the base, which is in the Paris Museum, No. 260*a*.

a. Locality not recorded. G. B. Sowerby, Esq. 38. 1. 8. 3. (Type).

126. **Montipora efflorescens.** (Pl. XXVIII. fig. 1; Pl. XXXIV. fig. 11.)

Description.—Corallum a confused mass of towering stems fusing irregularly together, each thickly covered with small lobes or branchlets pointing upwards. The whole mass rises from the surface or edge of an encrusting layer 0·5 to 1 cm. thick.

Calicles conspicuous, neatly star-shaped to the naked eye, 0·75 mm., irregularly distributed, here densely crowded, there scattered. The primaries well developed, stout, reaching to the half radius circle; directives. The secondaries distinct but small. Margin of the calicles clear; fossa deep.

Cœnenchyma a very pronounced streaming layer of delicate reticulum in the axes of the stems, and resting upon a solid basal layer in the encrusting portion of the corallum. This streaming layer proliferates at the tops of the stems and at the tips of the branchlets. In the latter it runs up as longitudinal ridges into elegant groups of tall, woolly and round-topped points and turrets, while on the flattened tops of the main stem it rises into angular systems of tall crests with deep narrow valleys in which star-like calicles open. Below these growing points and surfaces the reticulum runs out into tubercles rising from stout and very distinct trabeculæ. Almost the whole surface of the corallum, other than the crested parts named, is thickly crowded with small granular tubercles which are for the most part very uniform in size, under 0·5 mm. in height and thickness.

Of this interesting Montipore there is one large clump, about 15 cm. high and the same in its longest measurement across the top, and a single detached stem fitted in its place in the figure (Pl. XXVIII.).

In general method of growth, i.e. in the extraordinary richness and character of the cœnenchyma, it is closely allied to *M. ellisi*. At first sight it appears possible to regard it as a great proliferation of the edge of an old stock of *M. ellisi*. There are, however, three points that make me hesitate to put them together. The tubercles of this last type are much stouter, shorter, rounder and more densely packed, and form the whole surface. Whereas here the surface can be seen between the tubercles; more important still, most of the calicles of *M. ellisi* have a columella. But for these differences the two types could be easily combined.

Another superficial resemblance worth mentioning is to the more closely tufted specimens of *M. hispida* (Dana's *M. spumosa*). The differences, however, are great, the ridging and cresting only indicated in *M. hispida* are carried here to an extreme, the calicles are smaller and the tubercles more crowded. There is no trace of the smooth flaky surfaces between the tubercles and surrounding the calicles which characterises *M. hispida*.

a. (Two pieces fitted together), locality not recorded. [Register No. 97. 10. 9. 1.] (Type.)

127. **Montipora fimbriata.**

Description.—Corallum a flattened, fan-shaped tuft, growing from one or more narrow stalks obliquely upwards. The edge fringed with short free digitiform processes, which fuse, in the course of growth, longitudinally to form the body of the fan; living zone about 7 cm. deep.

Calicles conspicuous, rather scattered, look upwards towards growing edge, hence the outer walls project. Primaries variously developed, about to the half radius circle; directives may be pronounced, nearly meeting; only slight indications of secondaries. On the under surface the calicles in the younger half like those of the upper surface; on the lower older, smoother and more stony surface, as minute inconspicuous stars, somewhat scattered, and with broken margins and irregular septa.

The reticulum is very compact throughout, in the narrow stalks quite solid. The thickening layers of both upper and lower faces also soon become dense. On the under side, for some 3 to 4 cm. from the growing edge, the surface rises in tubercles and gyrating tubercular ridges, forming ramparts round calicles or angular plates; below this it is a smooth system of solid frosted plates or granules, with continually narrowing furrows between. On the upper side the tubercles are small, but they combine to form the protuberant outer walls of the sloping calicles, and are then either distinct or fused into irregularly swollen margins. There is thus no uniformity in the protuberant calicles.

Near the growing edge the streaming layer runs out into free processes more or less in the direction of growth, the smaller ones (5 to 6 mm. long) are smooth undifferentiated cœnenchyma, the larger and longer (12 mm.) are variously ridged and covered with tubercles

and calicles. Between the taller protuberant calicles, ridges, plates, &c., the small tubercles are like distinct granules, scattered over all the interstices. They are minute, compact, bushy, or frosted spherules of different sizes.

This Montipore is unlike any other in the Collection. The stock appears as if formed of several small fan-like growths, each growth due to the fusion of the fringing processes along its outer edge. A few of the component fans are regular, others are distorted and crushed together. One stalk is complete, and it is not more than 5 by 8 mm. thick: 5 mm. being about the thickness of each fan. The irregularity in the protuberant calicles, the fringe of processes pointing here and there, and the small grain-like tubercles dotting the interstices, joined with the peculiar method of growth, justify us separating this as a new species.

a. Warrior Island, Great Barrier Reef. Coll. Saville-Kent. (Type.)

128. **Montipora solanderi**. (Pl. XXIX.)

Madrepora foliosa, Ellis and Solander (*non* Pallas), Zoophytes (1786) p. 164, pl. lii.
Madrepora foliosa (partim), Esper, Forts., i. (1797) Tafel 58 *b*, figs. 1 and 2.
Montipora foliosa, Brüggemann, Phil. Trans., clxviii. (1879) p. 597.
(See prefatory remarks to *M. foliosa*, p. 156.)

Description.—Corallum a roughly circular bowl or dish-shaped mass of thick (7 to 8 mm.) fronds, usually broad, i.e. extending round half the circumference, but not deep, showing only a slight indication to curl spirally. The growing margin is thin (2 to 3 mm.) but thickens so rapidly on the upper surface that it looks as if the whole margin bends outwards; the under surfaces are not covered by an epitheca.

The calicles are small, 0·75 mm., inconspicuous, numerous, about 1 diameter apart, neatly star-shaped, with well developed primaries, thin and slightly exsert; one or two pronounced directives; traces of secondaries. On the under surface the calicles are scattered and like small irregular punctures.

Cœnenchyma shows in section a thick, dense, streaming layer from which thickening layers develop both upwards and downwards. The lower is denser, the trabeculæ stouter, and the tubercles into which they run are shorter and more solid, often surrounding the polyp cavities with dense protuberant rings. The trabeculæ of the upper layer are larger, but straight and stout and well marked; they are joined by thin ladder-like series of junctions. The tubercles of the upper surface are long, slightly feather-like, but with clear outlines, crowded in all stages of development, forming rings round calicles and ridges in all stages of fusion, the ridges giving rise to excrescences and even to tall branches. This profusion of cœnenchyma on the upper surface is also repeated irregularly on the under surface, where short tubercles are frequently developed and the calicles often appear protuberant, while round knobs, ridges and short branches occur. A level porous reticulum is everywhere visible between the tubercles and ridges.

There can, I think, be little doubt that the specimens here grouped together come very near the coral figured by Ellis and Solander. These authors endeavoured in their drawing to give some idea of the extreme richness of the surface cœnenchyma, while a smaller figure shows the rings of tubercles around some of the calicles. This feature is, however, confined to certain portions of the corallum, and indeed, in some of the specimens is hardly traceable.

The coral appears to be separated from *M. foliosa* by the greater thickness and slighter spiral twisting of the leaves, and by the closeness of the surface cœnenchyma, the tubercles, ridges, &c., thickly covering the whole surface. In *M. foliosa* the surface specialisation is more delicate and sparse, and more of the level cœnenchyma is visible.

(1) A large, flat, circular mass composed of almost horizontal fronds showing all the characters above described. The rings of tubercles round the calicles are not marked, while the upper faces of the older fronds are thickly covered with excrescences from all heights up to 5 cm.; small secondary fronds also appear; from the central fronds, thick knobbed branches 10 to 12 cm. high stand upright. (Pl. XXIX.)

a. Mauritius. Coll. de Robillard. 83. 7. 27. 6.

(2) A bowl-shaped specimen, composed of four or five fronds distinguishable only at their bases, where they appear to rise separately as conically rolled leaves. The fronds forming the outer rim of the bowl are fairly regular and continuous. The appearance of protuberant calicles is well marked on the inner surface, while on the outer surface the calicles stand out in parts as smooth tubes 2 to 3 mm. long. The inner fronds are very irregular, twisted, and distorted by excrescences.

b. Locality not recorded. [Register No. 97. 10. 9. 2.]

(3) Two specimens of a rich red-brown colour closely resembling *b*.

c, *d*. Mauritius. 88. 10. 25. 6 and 7.

(4) A flat, dish-like growth, from the surface of which arise a great number of jagged pointed branches about 4 inches long, mostly swollen near the top. The sides of these upright processes are covered with long tubercles, but at the top they run into numerous ridges or crests. At first sight this appears to be a very different coral from the above, but on closer inspection it is found to agree in all essential points, the only difference apparently being in the somewhat richer formation of branches, which may be due to some accident of growth. The same relationship between the purely foliate specimens of *M. australiensis* and *M. striata*, from the leaves of which a great profusion of branches arise, might perhaps be assumed, but there are in this case no other specimens to form any chain of connection.

e. Mauritius. 89. 3. 14. 4.
f. Mauritius (a fragment).

(5) There is another specimen from Mauritius labelled *foliosa var.*, which differs greatly from all the above but yet appears to belong here. The lower dead and corroded portions of the coral are typical, being formed by the fusion of several conically rolled fronds. On the

dying down of the older portion the subsequent growth has been quite irregular, perhaps rendered more so by the presence of Ophiurids, Molluscs and Crabs. The nearly upright fronds are wrinkled, ragged, and as if torn into irregular fringes, and from both surfaces there spring short irregular branches. Yet in these irregular fronds the disposition to curl spirally is traceable. I would suggest that this is part of an old stock which has lost the primitive symmetry of the fronds more completely than have any of the other specimens.

g. Mauritius. Coll. de Robillard. 83. 7. 27. 9.

(6) Five detached and broken fronds from Rodriguez, which were named by Brüggemann *M. foliosa*. They show all the characters of the above, but, being small, they are thinner and the specific marks are not so pronounced.

h. Rodriguez. Royal Society. 76. 5. 5. 76.

129. **Montipora striata.** (Pl. XXVIII. fig. 3; Pl. XXXIV. fig. 12.)

Description.—Corallum a thick, flat, dish-like expanse, the concavity being nearly filled up by thin vertical processes 5 to 6 cm. high and irregularly fused together. The sides of these processes are roughened by tufted groups of tubercles, while, from the tips, smooth, longitudinally striated spikes or points shoot up 4 to 5 mm. above the calicles and tubercles. The corallum is attached by its centre and there is no epitheca.

Calicles distinct, and except on level explanate portions, star-like, about 1 mm. or less in diameter. Parts of two cycles of septa, irregular, thin and rod-like, slightly swollen at their tips; the fossa is clear and deep. On the under surface the calicles are numerous; close around the edge they open on the surface of the corallum and have irregular septa; nearer the centre they are slightly protuberant, with six well-marked, thick, regular and slightly exsert septa.

The cœnenchyma is remarkable for a thick laminate streaming layer. At the growing edges and at the tips of the vertical processes this layer shoots out beyond the rest of the corallum. Round the edges it mounts up into thick, coarse, very friable ridges and spikes, all longitudinally striated. At the tips of the branches the spikes are graceful and often sharply pointed. In all cases these protrusions of the streaming reticulum are longitudinally striated with projecting laminæ which are white against a red-pink core. From the thick streaming layer the trabecular layer arises somewhat suddenly. The smooth, thick and irregularly crowded trabeculæ are very short, but above the surface they rise up into tall, feathery but compact tubercles, usually in dense clusters which are typically associated with calicles. The further growth and branching of these clusters give rise to the vertical processes, on the sides and especially round the bases of which single calicles, carried up by compact groups of tubercles, may stand out 2 to 3 mm. The calicular aperture is right at the top of such out-

growths, and the septa start from the inner faces of the tubercles. Between these taller clusters of tubercles, the surface consists of the feathered tops of the trabeculæ, loosely bound together, while in deep depressions, rapidly filling up with cœnenchyma, the surface is an undifferentiated loose reticulum, densely crowded with conspicuous but quite regular calicles.

On the under surface the trabeculæ form a mosaic of broad but irregularly shaped plates, separated by deep fissures; each solid plate may perhaps be composed of two or three fused trabeculæ, its surface being marked by groups of fine white points. These thickened trabeculæ, forming a raised wall round the calicles, give rise to the thick solid septa.

There is only one specimen of this beautiful coral, which is characterised as well by the spike-like protrusions of the streaming layer as by the clumps of tubercles which raise the calicles above the surface. In this latter feature we find an explanation of the prolific formation of erect processes. In this respect it resembles specimen *e* of *M. solanderi* which is also dish-like and forms great numbers of erect processes. The fact that this particular specimen of *M. solanderi* appears to be only a special method of growth of that type, leads one to suspect that *M. striata* may be but another form of *M. australiensis* from the same locality. The striate edges and the knobbed septa are features which they have in common. There is no reason why these two may not be closely related; until, however, we have the direct evidence of transitional forms, it is better to describe them separately. The colours of this coral are very beautiful. The spikes and growing edges are suffused with rose-pink, while the sides of the processes are olive-green, against which the white tubercles stand out in contrast.

a. Houtman's Abrolhos. Coll. Saville-Kent. (Type.)

130. **Montipora circinata.***

Description.—Corallum forms a single conically twisted frond, rising from a narrow band-like base; the edges curl round spirally and overlap but do not fuse; 2 mm. thick at growing edge and rapidly thickening to a centimetre or more near the base.

The calicles are small, 0·50 mm., conspicuous owing to the depth of the open fossa, scattered, and for the most part confined to the depressions between the cœnenchymatous elevations; the primaries are but slightly and irregularly developed, and there are only faint traces of the secondaries. On the under surface, while many calicles are mere openings in the level reticulum, others are walled round by uprisings of the cœnenchyma. The whole outer surface is covered with irregular prominences 2 to 3 mm. high, with calicles on or near their tips.

The cœnenchyma. A section through the base shows the compact middle reticular layer and inner and outer compact trabecular layers; while the outer layer is very compact and more reticulate, the inner layer is composed of thick and not very closely packed trabeculæ.

* This name is suggested by Mr. Saville-Kent in 'The Naturalist in Australia,' 1897, p. 146, for this coral, which is figured on the same page and also on pl. xxiv., upper figure. The coral is not, however, described.

All the level portions of the inner and outer surfaces consist of a very open reticulum having a granular appearance to the naked eye, whereas the tubercles rising above the inner surface and forming plates and ridges are compact feathery structures. The ridges are thick and pronounced but discontinuous; they are tallest round the edge, but are distinctly traceable more than half-way down the cone generally as rows of tubercles which are round and swollen, sometimes almost spherical. These tubercles are not confined to the rows, but also frequently form half rings round the lower borders of calicles. The inner surface of the cup is very irregular, there being numerous nearly smooth depressions without ridges or tubercles, these depressions corresponding with an elevation on the outer surface of the cone.

There is only one small bluntly conical specimen of this coral in the National Collection. Another, larger, taller and more pointedly conical, however, has been figured by Mr. Saville-Kent in 'The Naturalist in Australia,' 1897, where it is stated that in life it is of a pale pinkish-red hue, with lighter edges; it is found in deep water, occurring in distinctly isolated patches many yards square.

There can be little doubt of the affinity of this coral to *M. foliosa*, with which it agrees in its being rolled into a deep conical spiral. In *M. solanderi* the leaves are more open and the spiral coiling not very pronounced. The cones are deeper and more pointed in this type and in *M. foliosa*, while in other forms (cf. *M. crassifolia*) the stocks consist of erect bundles of crumpled and ragged fronds.

Judging from an examination of the single specimen in the Collection, the lower portions of the cone seem to die down and then to be overrun with fresh coral from the upper living portion. An epitheca appears under the downwardly creeping layer of coral. In the specimen here described, there are traces of some four successive overlayings of the base with fresh coral, strengthening it as the corallum grows slowly in height.

a. Palm Islands. Coll. Saville-Kent. 92. 12. 1. 1. (Type.)

131. **Montipora foliosa.**

This specific name was first used by Pallas ('Elenchus,' 1766, p. 333) to include not only the foliate Montipores, the originals of which he had seen, but also those figured by still earlier writers. His general description runs as follows:—

The stock consists of a group of leaves showing a rose-like arrangement and either rising from a thick stalk or else from the smooth rock. The leaves are of moderate thickness, rudely petaloid (those near the centre being usually smaller), of varied form, with frilled or folded edges, but irregularly as if torn, with both faces very rough as if scraped with a jagged chisel. Small scattered calicles stand up from among the irregularities of both surfaces of the leaves. From the Indian Ocean.

Among the specimens seen by Pallas, some were almost perfectly rose-like, sometimes with fewer leaves at the centre. In some the leaves were thinner and more torn, as for instance in the excellent figure given by Turgot (Mem. Instr., pl. xxii A). In others, again, the leaves were

thicker and with smoother surfaces. Sometimes interspersed among the leaves, rough awl-shaped processes with conical points and bearing calicles are met with—apparently of the same substance as the leaves. Very frayed and torn fragments also occur, but being of essentially the same structure they are to be accounted for by accidental distortion. Some specimens, again, consist of only a few large coiled leaves not unlike the cup corals figured by Seba and Gaultier.*

In 1786, Ellis and Solander applied the name *foliosa* to a coral from Mauritius, which may perhaps have been identical with one of the many Montipores seen by Pallas.

In 1797, Esper found it necessary, in describing the species, to illustrate it by reproducing the figures of Seba, Ellis and Solander, and also that of Turgot which Pallas had specially commended as 'icon bona.'

In 1816, Lamarck somewhat hesitatingly limited the name *foliosa* to Ellis and Solander's specimen, giving the name *rosacea* to the cup corals of Seba and Gaultier. These, he said, were not rare, but their form was remarkable.

Since that date it is probable that many foliate Montipores have been labelled *foliosa*, although a few new names have been suggested, e.g. *grandifolia* of Dana, *exesa* and *lichenoides* of Verrill; and further, the *Agaricia lima* of Lamarck was recognised by de Blainville as a Montipore and classed next to *foliosa* by Milne-Edwards and Haime.

Examination of the foliate Montipores in the National Collection has revealed certain fairly well marked differences, in spite of a most bewildering variability not only in the forms of the leaves, but also in the surface markings; the latter seems largely to depend upon the form and position of the leaves and their subjection to or freedom from crowding. The separate leaves of a stock which has been hindered from growing symmetrically might supply one with many species.

After many vain attempts to arrange the foliate Montipores in the National Collection under the different specific names found in the literature, viz. *foliosa*, *lima*, *rosacea*, *grandifolia*, *exesa*, and *lichenoides*, I found it necessary, after separating *M. circinata* and *M. solanderi*, to divide the rest into two main groups, one under the old name *foliosa* and the other under the name *crassifolia*.

In the former, the leaves are thin, spirally coiled, forming rather sharp cones, e.g. the cup coral of Seba.

In the latter, the leaves are thick and bending upwards form together deep bowl-shaped coralla. The upper edges of the leaves are generally greatly crumpled and torn, and sometimes run out into tall ragged ends. The spiral coiling is always traceable at the lateral edges of the leaves and elsewhere.

Among the representatives of the former group great differences occur in the prominence or subordination of the longitudinal ridges, but it was impossible to classify them, owing to the gradual transitions and to the variations obviously due to the accidental positions of the leaves. A satisfactory classification will only be possible when we have longer series of specimens including those which show the early stages of growth. The latter are especially needed, in order to explain how the intercoiled clusters of spiral leaves come into existence. On this point see below the description of specimen *r*.

* For references see the synonymy.

Montipora foliosa. (Pl. XXX.; Pl. XXXIV. fig. 13.)

Choana saxea, Gaultier, Index (1742) pt. iii. pl. xlii.
Corallium infundibuliforme, Seba, Thes. Nat., iii. (1758) p. 203, pl. cx. fig. 7.
Madrepora foliosa (partim), Pallas, Elenchus (1766) p. 333.
Madrepora foliosa, Boddaert, Syst. d. Pl. (1768) p. 411, pl. ix. fig. 6.*
Non *Madrepora foliosa*, Ellis and Solander, Zooph. (1786) p. 164, pl. lii. (= *M. solanderi*).
Madrepora foliosa, Esper, Fortsetz., i. (1797) p. 67, Tafel 58A and 58B fig. 3.
Porites rosacea, Lamarck, Anim., ii. (1816) p. 272.
Agaricia lima, id. op. cit., p. 243.
Montipora lima, de Blainville, Manuel (1834) p. 389.
Montipora rosacea, id. ibid.
Non *Manopora foliosa*, Dana, Zoophytes (1848) p. 497 (= *M. tuberosa*, Klz.).
Manopora lima, id. op. cit., p. 505.
Montipora foliosa, M.-E. and Haime, Cor., iii. (1860) p. 212.
Montipora lima, id. op. cit., p. 213.
? Montipora foliosa, Verrill, Proc. Essex Inst., vi. (1871) p. 85.
? Montipora exesa, id. op. cit., p. 84; see also vol. v. p. 25 (= *? M. prolifera*, Brüggemann).
? Montipora lichenoides, id. op. cit., p. 86.
Montipora foliosa, Studer, MB. Akad. Berlin (1878) p. 538.
Non *Montipora foliosa*, Brüggemann, Phil. Trans., clxviii. (1879) p. 577 (= *M. solanderi*).
Montipora lima, Brüggemann, Journ. Mus. God., Heft xiv. (1879) p. 201.
Montipora foliosa, Quelch, Chall. Rep., Reef Corals (1886) p. 175.
Montipora exesa, id. ibid. (? Verrill).
Montipora grandifolia, id. ibid. (*non* Dana).
Montipora lima, id. op. cit., p. 176.
Montipora foliosa, Bassett-Smith, Ann. and Mag. Nat. Hist., (6°) vi. (1890) p. 450.

Description.—The adult symmetrical stock consists of rose-like clusters of spirally coiled leaves, each leaf forming part of a sharp cone and making an angle of about 45 degrees with the horizon. The leaves are thin at the edge and frequently longitudinally wrinkled. No epitheca is visible at this stage.

The calicles average about 0·75 mm. across, with six thin primaries well developed, secondaries rudimentary. The apertures are sometimes conspicuous, sometimes obscured by the tubercles. They are mostly protuberant, that is, surrounded by rings of tubercles within which they rise, the septal spines projecting from the tubercles. On the under surface the calicles are numerous and irregularly protuberant so that the surface looks rough.

The cœnenchyma consists of a dense laminate streaming layer which forms a thin but dense, almost stony under surface to the leaves; through this the calicles protrude. On the

* This work is an illustrated Dutch translation of Pallas' 'Elenchus.' The figure is borrowed, doubtless because of Pallas' commendation, from Turgot's Mem. Instr., pl. xxiiA.

upper surface the streaming layer rises in thin longitudinal ridges which either persist, rising in height and width in the older parts of the leaves, or are soon lost among the tubercles which appear in the thickening layer. In this case the tubercles are very numerous, and tend to be grouped round calicles so as to give the surface a lumpy appearance.*

(1) Five more or less fragmentary specimens from Amboyna, labelled by Quelch "*M. foliosa*, Pallas." These are especially instructive because they contain forms with jagged irregular leaves like that figured by Turgot, as well as symmetrical rose-like stocks. The largest, *a*, appears to have been part of a symmetrical sharply conical roseate stock. Specimen *b* is a less regular group of leaves; *c* is a long, very ragged and twisted leaf which might have been broken out of the centre of some more symmetrical stock; while *d* and *e* are fragments bearing a striking resemblance in general form to the coral figured by Turgot. The fronds are about 1 mm. thick at the growing edge and 3 in the thickest part (i.e. when not encrusted over by fresh layers.) The calicles are about 0·5 mm. in diameter, and though not conspicuous are quite visible, being best seen when the coral is held up against the light. The margin of the aperture is well defined. The six well developed septa are seen with the rudimentary secondaries. The calicles are very scattered, often occurring in irregular bands roughly parallel with the growing edge. The longitudinal ridges are not pronounced, but are sometimes traceable for a long way down the frond, or, again, they may be hardly developed at all. The tubercles are very pronounced and scattered, being grouped irregularly; they are very thin, either feathery or else jagged and perforated plates, about 1 mm. high. The transition from the ridges into the tubercles can be followed in all its stages. The under side is dense with scattered calicles raised above the surface; between the calicles the interstices are smooth. In section, the under layer is seen to be quite solid. Compare with these the five fragments *u*, from the same locality, and, from the fine texture of the surface, belonging to the same type.

a, b, c, d, e. Amboyna. H.M.S. 'Challenger.'

(2) A large, symmetrical, rose-like cluster of fronds (Pl. XXX.); each frond seems to form at the base a conical point and to be growing from the edge of a dead frond. The fronds slope outwards at an angle of 45 degrees; the upper edges being about 5 to 6 cm. apart. The growing edge is about 1·5 mm., and rapidly increases to 3 mm. thick. By holding a frond up to the light the following characters are at once apparent. The ridges and tubercles form a regular and delicate tracery of almost parallel lines about 1 mm. apart. The calicles open in the deep valleys between the ridges, and are moreover bordered above and below by tall tubercles, not infrequently a ridge ends against the lower tubercular wall of a calicle. Small clusters of calicles close together often lead to the formation of a small prominence. Under the lens, the tubercles and ridges are beautifully and finely jagged, as if frosted over. The under surface is very dense, but is covered with slightly protuberant calicles and with indications of tubercles, which hardly rise above the dense cœnenchyma, except as small groups of jagged points. They give the surface a granular appearance to the naked eye. The laminate character of the middle streaming layer is very marked at the growing edges where it causes a striation of the surface.

* For description and coloured figures of a living coral, regarded as belonging to this species by Mr. Saville-Kent, see his 'Great Barrier Reef,' p. 184, and chrom. pl. viii. fig. 5.

Some of the fronds are smooth, and others so wrinkled as to be thick and very roughened by the multitude of prominent upgrowths of the cœnenchyma, which here and there form finger-like processes an inch long. The young and very thin fronds, starting from the upper faces of older fronds or curling round from their uppermost lateral edges, probably form together the starting of a new cluster which would in time cover over the old as a still larger and more imposing stock.

f. Mauritius. [Register No. 83. 7. 27. 8.]

g, *h*, *i*, *j*. (Detached fragments of the same.)

(3) Two specimens which can be fitted together to form a tall, sharply conical mass of fronds. The lower, pointed, basal portion is corroded and covered with algæ. The upper portion is composed of curling and irregularly intertwining fronds, not crowded together, and with the thin edges curved slightly upwards so that the under side is slightly bulged outwards. The large fronds seem to have grown by successive ladle-shaped bulgings, hardly sufficiently marked, however, to obscure their conical shapes (cf. *M. friabilis*, p. 138 and Pl. XXIV.). The cœnenchymatous ridges are only visible near the growing edge, after which they are soon obscured. The tubercles, which thickly cover the corallum, tend rather to form walls of thin plates arranged at all angles, but seldom in line with the ridges. These flat plates slope towards the growing edge and thus hide the calicles which are hardly visible when the corallum is held up to the light. The corallum is little more than 1 mm. thick at the edge, and reaches 3 mm. The cœnenchyma is very dense in the upward streaming and lower layers. On the under side, the numerous minute calicles are immersed near the edge, but lower down may open on small protuberances, or else be surrounded by rather solid rings of short stout tubercles.

This specimen might perhaps have been described under a separate heading as a variety.

k, *l*. Ramesvaram, Gulf of Manaar. E. Thurston, Esq. 88. 11. 25. 2.

(4) A very beautiful specimen (labelled *M. lima*), unfortunately greatly broken. The fronds together form a rather expanded cone; the individual fronds do not curl so much into steep cones, but starting as thin strips often only 2 to 3 cm. across, they expand into tall, slightly curled fronds; the whole cluster is grouped roughly into concentric circles. The cœnenchymatous ridges are very marked for 5 to 6 cm. from the edge, of various thickness and height, the thicker rising irregularly into jagged points, which slope upwards. Lower down on the corallum, most of these vanish and only a few rise, often two together, into thick sharp ridges covered with tall, saw-like, angular points which may be an inch high; between these ridges the interstices are smooth, and the calicles open in great numbers on the surface (Pl. XXXIV. fig. 13). Individual fronds occur in which the ridges are less conspicuous and the tubercular formation correspondingly better developed. The under surfaces of the fronds are finely striated by the laminate streaming layers, and in the case of the outermost fronds, short tubercles may cover the surface and surround the calicles with prominent walls. The identification of this with *M. lima*, Lamarck, by Quelch was, I think, quite correct. But Lamarck's *M. lima* was founded upon small thin fronds, slightly coiled, more or less fragmentary and characterised chiefly by the thin longitudinal ridging. The species *lima* must, I think, be merged with *foliosa*.

m. Zamboanga. H.M.S. 'Challenger.'

n, *o*. (Fragments of same.)

(5) A specimen from the same locality, Zamboanga (labelled *M. exesa* Verrill) which close comparison shows to be specifically identical in spite of the differences in superficial aspect. The difference is brought about by the early suppression of the ridges and the greater profusion of the tubercles. The surface is roughened by the walling round of the calicles by thick clusters of variously fused tubercles with deep depressions between the clusters, while here and there the ridges which persist among these clusters of tubercles rise up into tall spikes as described for specimen *m*. In the depressions between the clumps of tubercles the frond is so thin that the daylight can be seen through the pores. These specimens *m* and *p*, so unmistakably connected together by the form of the fronds, by the calicles in the smoother areas, by their under surfaces, by the tall spikes from the ridges, and yet so different in the surface aspect of the fronds, go far to justify the provisional union of all these specimens under one head.

p. Zamboanga.

(6) A complete small symmetrical flower-like stock, the conical fronds being much crumpled round their edges, the rich surface cœnenchyma showing the ridge and tubercular formation about equally developed. The chief peculiarity about this otherwise typical growth is, that the ridges are delicate saw-like rows of separate tubercles. The locality is unfortunately not recorded.

q. Locality not recorded. [Register No. 97. 10. 9. 3.]

(7) A small (perhaps young) stock (*r*) consisting of a small flat encrusting portion, the sides of which, broken into lobes, bend steeply upwards and begin to form conically twisted fronds. In the hollow of the basin thus formed the tubercles are very richly developed, while round the thin turned-up edges the ridges are appearing. The wall-like plates protruding from the under margin of the calicles on the steep slopes are often mere latticework. The specimen was labelled *M. foliosa* by Brüggemann, and may well be the first encrusting stage of a typical rose-like stock; the coiling lobes of its sides perhaps developing into the fronds of the adult.

? *r*. Locality not recorded. [Register No. 97. 10. 9. 4.]

(8) There are in addition two single leaves clearly belonging to this species, and showing a well-developed ridge and tubercular formation. On the larger, *s*, the ridges tend to be rows of separate tubercles. It was labelled *M. foliosa* by Brüggemann. The smaller specimen *t*, only a few sq. cm. in size, was labelled *M. grandifolia*, Dana, but it shows no special feature separating it from *M. foliosa*.

s. Locality not recorded. [Register No. 55. 12. 27. 92.]
t. Api, New Hebrides. H.M.S. 'Challenger.'

(9) Five beautiful little fragments (*u*) from the edges of thin, curling fronds presumably belonging to this type. The specimens retain the original colours of the corallum, whitish olive greens changing into rich red browns. They further show the marvellous varieties of surface growth, one having tall thin ridges which are hardly developed at all in the others.

Treated as fragments alone they would be arranged under three separate headings. Compare specimens *a* to *e* from the same locality.

One of these specimens is remarkable for the small chambers in its upper surface, the mouths of some of which are partially closed by a ring of curved spikes not unlike septa, the whole chamber thus looking like a rather irregular calicle. These chambers seem to have been inhabited by small Crustacea, the chitinous skins of which can still be seen in many of them.

u. (Five fragments of fronds.) Amboyna. Vienna Museum.

(10) The last is a small but beautiful fragment which apparently belongs to this species and was so classified by Bassett-Smith.

w. Macclesfield Bank, 20½ fathoms. H.M.S. 'Rambler.' 89. 9. 24. 59.

132. **Montipora crassifolia.** (Pl. XXXIV. fig. 15.)

(Established provisionally to embrace those thicker-leaved foliate Montipores in which the fronds bend upwards and form a deep bowl of crumpled leaves, the edges of which fray out. See above the prefatory notes to *Montipora foliosa*.)

Description.—Corallum a deep, bowl-shaped cup with nearly perpendicular sides, composed of thick (5 mm.) leaves with a spiral twist more or less pronounced, the leaves mostly very wrinkled and ragged along the upper edges. The hollow of the bowl is filled with curling wrinkled leaves which freely fuse, and the outer surface is gnarled by the wrinkles and by thick ridges which run out into projections. The epitheca only traceable right under the base of the bowl.

Calicles very scattered and very unequal in size, a few reaching nearly 1 mm. in diameter. They occur in irregular groups or rows with spaces sometimes 4 mm. wide between. The septa in two cycles, but the second may be imperfect while, on the other hand, in single large calicles traces of a third cycle may appear, the septa then all being small and the fossa very large and distinct. The primaries very frequently terminate in distinct knobs; directives generally conspicuous. The calicles on the outer side of the fronds do not differ from those on the inner, except when situated in unfavourable places.

Cœnenchyma shows a very pronounced laminate streaming layer which comes to the surface for 1 to 2 cm. deep along the growing edges. This gives a finely striate appearance to the smooth zone of the under surface, but on the upper surface it rises in feathery ridges and tubercles in which the streaming of the cœnenchyma is quite distinct. The thickening layers are very irregular and seem to be a reticulum largely composed of solid blocks which either form a mosaic at the surface or else rise into tall stout tubercles. Hence, the surface is very irregular, consisting of patches of smooth mosaic, each block being finely frosted and granulated, or else very rough and rugged owing to the dense masses of coarse granulated tubercles. These tubercles tend to rise into tall rings round individual calicles which, by the fusion of

the tubercles, may stand right up cup-shaped. Similarly, the feathery ridges of the streaming layer near the growing edges are generally associated with young calicles.

The finer details given in this description are taken from the only specimen of this kind in the National Collection. I have, however, seen others, notably a fine series in the Paris Museum, which probably differs from the above in some details, and also in the extraordinary profusion with which the edges of the fronds fray out, rising up into tall ragged flames; these in old stocks may completely obscure the bowl stage of the stock, which may ultimately become a tall, erect, tapering compact bundle of crumpled ragged flames. My notes contain no information as to the locality of these specimens.

In the base of the bowl in the British Museum specimen a large Ophiurid was imprisoned.

a. Locality not recorded.	97. 5. 18. 5.	Types.
b. Eight fragments of same.	97. 5. 18. 4.	

133. **Montipora plicata.** (Pl. XXXIV. fig. 14.)

Description.—Corallum consists of clusters of leaves (form of grouping unknown), about 10 cm. long and 6 wide; these are either flat or with the sides curled up. The growing edge is thin, from 2 to 3 mm. A well developed epitheca follows to within 2 to 5 mm. of the edge. Crumpling of the leaves is very common; the sides fold under, and thick, knobbed and irregular plates, some 7 mm. thick, are formed from which all symmetry is lost.

The calicles are numerous but unevenly distributed; on the thin leaves they are more than 0·5 mm. in diameter, but on the thicker irregular expanses they reach to nearly 1 mm. Wherever the cœnenchyma is very richly developed into ridges and tubercles, the calicle apertures tend to protrude as thin, delicate, membranous rings from the inner face of which twelve short but symmetrically arranged septa project, there being often no great difference between the two cycles. These leave a large open fossa which is very deep on the thicker crumpled leaves.

The cœnenchyma. The sections show a laminate streaming layer with a solid deposit on the epitheca. This deposit may be over 1 mm. thick. The surface shows great variation. Thin leaves may be merely traced over with very thin gyrating ridges which form angular patterns round the calicles and combine somewhat to give an appearance of longitudinal ridging. These longitudinal ridges may stand up very prominently and overshadow the rest. On thicker and apparently more horizontal leaves, these longitudinal ridges may break up into short lengths so that the whole surface may be covered with thin, flat points or square plates, 1·5 mm. high, arranged for the most part in longitudinal rows not more than 1 mm. apart, and between which calicles with their protuberant membranous margins open.

On still more irregular leaves, the longitudinal arrangement of these plates may be lost and they may run together at all angles or rise to great heights, 4 mm., and crested processes may arise, while on the more level surfaces large tubercles may appear.

The tubercles, singly or in groups, only appear in close relationship with the protuberant membranous calicles, so that the whole surface appears covered with protuberant calicles, their walls being made of large papilla-like tubercles.

There are 16 pieces of this coral, consisting of whole symmetrical leaves and fragments of leaves, together with thick, bent and distorted plates; these appear to be parts of a large stock, or cluster of leaves. The variation presented by these fragments is marvellous: at least four types could be made out of them. They all came together as one specimen, and close comparison shows that they shade off into one another and in spite of all their differences belong to one and the same type. Great variability of the fronds forming these foliate clusters is what we have already learnt to expect from *M. foliosa*. The tubercles in these specimens only appear on the flatter and thicker leaves and on the distorted growths: the connection between the thin flat ridges and the tubercles is very marked.

a. (In sixteen pieces.) Torres Strait. Prof. A. C. Haddon. 97. 3. 9. 206. (Type.)

134. **Montipora hirsuta**. (Pl. XXXIV. fig. 16.)

Description.—Corallum, complete form unknown, probably dish-shaped with turned up edges, which are very friable and of varying thickness, from 3 to 5 mm.; from the floor of the stock, tall, thin upgrowths, often only 3 mm. in diameter and 3 cm. high, rise up either singly or fusing into plates and into solid cliff-like formations. The sloping edges of the stock rise freely without epitheca.

The calicles are conspicuous, irregularly scattered, and vary greatly in size, the largest and most protuberant being slightly less than 1 mm. in diameter. Those raised slightly above the others are frequently surrounded by thin, membranous, funnel-shaped ramparts, the edges of which run out into long hair-like points. The aperture generally sharply circumscribed, with petaloid interseptal loculi and either short primaries with very rudimentary secondaries, or primaries and secondaries nearly equally developed, but all short, the fossa being large and conspicuous. In individual calicles, a columella-like body appears in the base of the fossa and is sometimes very large, conspicuous, and fused with the edges of the septa. On the under surface, the calicles are very numerous and vary greatly in size, the larger often with slightly raised ring-like margins, the smaller being mere pores with a radiate arrangement of surface granules suggesting the septa.

The cœnenchyma is very friable; the streaming layer is thick, open, and laminate; where it forms the growing edges it is very delicate and friable. The streaming layer rises in very thin membranous ridges which are often merely horizontal rows of sharp hair-like points; the young calicles are often surrounded by such thin ragged walls. On the thicker part of the corallum, the thin ridges give place to fine tubercles which fray out into thin flame-like points. Small compact groups of calicles, raised and surrounded by membranous ramparts, may rise higher and higher above the surface to form the tall, thin, stick-like

processes above mentioned. The under surface is a close reticulum covered with small granules or groups of granules.

The only specimen representing this type is a small fragment which there is reason to believe is one of the specimens of the Lister Collection from Tongatabu which was somehow overlooked and not labelled. If so it is specially interesting owing to its many points of resemblance with *M. calcarea*. As stated in the description of that coral, I was long in doubt whether it was not merely a corroded specimen of the coral now described. I do not, however, go beyond suggesting this possibility, as there are serious difficulties. For, while it is possible that the very thin tubercles and echinulæ of *M. hirsuta* might corrode off, leaving only the membranous ridges which characterise *M. calcarea*, it is strange that the septa should be so clearly cut and preserved. It is true, of course, that the dead mass of the oral disc and subjacent œsophageal and mesenterial tissue might protect the septa from corrosion a little longer than the thin skin could the echinulæ; still, the closer I compare the types, the less inclined am I to consider them identical without further evidence.

We must therefore consider this as a separate species, closely resembling *M. calcarea* in coarser structural features, but very different from it in the presence of tall, thin, glassy tubercles run out into fine hairs. These often unite to form very thin gyrating ridges like membranes with ragged edges. The rising groups of calicles with thin, funnel-shaped ramparts are common to both types, and in both, these may form tall, thin, stick-like processes.

In its great friability, the specimen reminds one of *M. friabilis*, but there is no other likeness.

a. Tonga (?) J. J. Lister, Esq. (Type.)

135. **Montipora bifrontalis.**

Description.—Corallum thin, encrusting, with free lobate edges, the lobes curve upwards, and are at the edges shallow spoon-shaped. Edge slightly frilled, thin, 1 to 1·5 mm., smooth, and indented by developing calicles. The epitheca leaves the greater part of the under surface of the spoon-shaped lobes free.

Calicles about 0·5 mm. in diameter, unevenly distributed, often widely scattered, on the upturned slopes opening at the tips of thin nariform ridges, on the more level portions and on the under surface as irregular, cylindrical protuberances, the margin of the protuberance generally running up on one side into separate tubercles or into fused plates. The septa in two cycles, short and stout, symmetrically arranged; slightly thicker directives; deep fossa; the margin of the calicle not sharply circumscribed. On the under surface, the septa are less developed and the fossa is much more open; the numerous calicles opening on the turned-up under edges of the spoon-shaped lobes are slightly depressed.

Cœnenchyma appears to be an open filamentous reticulum, the upper and lower surfaces appearing very dense and covered with innumerable frosted granules. The tubercles, which rise above the surface, are not sharply defined, but generally unite to form either hoods for the

sloping calicles, or their protuberant walls; the lower ends of the nariform ridges may break up into tubercles. Small irregular upgrowths from the encrusting portion of the stock are covered with short, slightly wavy ridges of even thickness and with rounded tops. These, running in different directions, give the prominences a jagged appearance.

There is only a single small specimen of this coral, which I have been unable to associate with any of the foregoing. The method of growth of the specimen might be that of a young *foliosa*, the encrusting portion throwing out free upwardly curved lobes. For this reason I at first included it among the specimens of *foliosa*. On the other hand, there is no evidence that this stock would have formed a foliate stock, and further, the nariform ridges are quite different from the ridges in *M. foliosa*. Then, again, the calicles developing on the turned-up under-surface of the thick rounded edges (which suggested the specific name) is very unlike what is found in *M. foliosa*, where the edges are very thin, and though calicles are very numerous on the under surface, they rarely appear within a cm. or two of the edge. Lastly, the peculiar ridges on the small prominences remind one most of those of *M. viridis* (see p. 99, Pl. XXXIII. fig. 10), and the whole coral has the same peculiar glassy appearance, only the colour is red-brown, almost a red peach-colour round the edges on the under side.

The specimen is further interesting because a portion which has been folded down under the rest has the whole surface texture with the margins of the calicles so remarkably developed that one would fancy that there could be no specific connection between that portion and the more normally growing remainder of the colony.

a. Palm Island, Great Barrier Reef. Coll. Saville-Kent. (Type.)

The Genus ANACROPORA, Ridley.

I. HISTORICAL.

This genus was founded by Mr. S. O. Ridley in 1884* to contain a small branching stock, from Keeling Island, which was neither a Madrepore nor a Montipore. From *Madrepora* it differed not only in the absence of any axial corallites, but also in the fact that the tips of the branches were composed of undifferentiated cœnenchyma. The young calicles developed in this tip, so that each new calicle appeared above that last formed. This method of growth Ridley called "centripetal," while that of *Madrepora* was called "centrifugal," because the daughters appeared below the central or apical polyp.

The coral was also apparently not a branched *Montipore* (although nearer to that genus than to *Madrepora*), because the calicles were slightly protuberant, a feature not typical of the *Montiporæ*; and, again, the undifferentiated cœnenchymatous tips of the branches, without calicles, was thought by Ridley not to occur in *Montipora*. To this supposed peculiarity of the new specimen the generic name *Anacropora* referred.

On account, then, of the supposed fundamental difference in the methods of budding between *Madrepora* on the one hand, and *Montipora* and *Anacropora* on the other, Ridley suggested the formation of the two sub-families, Madreporinæ with the genus *Madrepora*, and the Montiporinæ with the genera *Montipora* and *Anacropora*. This is the arrangement here adopted, although on an entirely different line of argument.

In the same year 1884, in revising Milne-Edwards and Haime's system of the Madreporaria, Duncan† accepted the genus, definitely associating it with *Montipora*. The two together formed the "Montiporoidea," which was the second alliance of the Poritidæ, Duncan in this returning to Milne-Edwards' association of *Montipora* with *Porites* rather than with *Madrepora*. (See introduction to genus *Montipora*.)

In 1886, Quelch described two new species collected during the 'Challenger' expedition, one from Banda and the other from Kandavu. He placed the genus near the end of the Madreporidæ after *Astræopora*, and before *Montipora*, which genus, probably as some concession to Duncan, was made to lead on to the next family, the Poritidæ.

In 1892, Dr. Rehberg, in his account of the Madreporaria in the Hamburg Museum, described a new species (*A. spinosa*), from the Pelew Islands, differing remarkably from the three species already described, not only in being covered with long thorn-like processes,

* Ann. and Mag. Nat. Hist., xiii. p. 289. † Journ. Linn. Soc. Zool., xviii. p. 192.

but in the absence of protuberant calicles. The stock was also much larger than any of those known. While this coral appears to belong to this sub-family, its generic affinities are somewhat uncertain.

Including Ridley's and Quelch's types, there are at the time of writing twenty-two specimens, several of which are mere fragments, in the National Collection. Examination of these has resulted in the establishment of two new species, making six in all. An account of the morphological results has already been published in the Ann. and Mag. Nat. Hist., xx. (1897) p. 127.

II. MORPHOLOGICAL.

The Anacroporæ agree in all important structural features with branching Montipores. There is the same axial streaming layer, which is frequently laminate. This axial layer forms in both * the growing cœnenchymatous tips of the branches, and in it the young calicles first appear. A cortical layer is developed, but seldom attains any great thickness, hence it is frequently raised into protuberances by the growing calicles. Whereas, in the calicles which do not raise the cortical layer, the septa have the same characters as those of *Montipora*, being stunted to mere vertical rows of spines, in the more developed protuberant calicles the septa may be laminate structures, the radial prolongations of which even project down the sides of the protuberances as true costæ.

Summarising, then, the points in which *Anacropora* differs from *Montipora* we have, in all, four distinguishing characters :—

(1) The method of branching.

(2) The protuberance of the calicles consequent on

(3) The thinness of the cortical layer.

(4) The development of laminate radial structures as septa and costæ in the protuberant calicles.

The method of branching.—This is very characteristic. The rising stem gives off a branch at a generally wide angle, itself bending away from the branch. Both these may again branch and rebranch. The result is the formation, not of rising tree-like stocks with the branches directed mainly upwards, but of closely matted tangles comparatively low down near the ground and complicated by frequent fusions. The meshes in such a tangle tend to be angular, although curvings of the branches and stems may obscure this latter characteristic. This matting or tangling is very pronounced in Ridley's original species *A. forbesi*, in Quelch's *A. gracilis*, and *A. solida*, and in one of the new species here established, *A. reptans*. It is not so clear in Rehberg's *A. spinosa*, or in the other new species here described, *A. erecta*. In these two latter the comparative smallness of the diverging angle of the branches causes the stocks to approach the arborescent.

* Mr. Ridley was not aware that this was also the case in *Montipora*, and made it one of the distinguishing features between *Montipora* and *Anacropora*.

The calicles.—True protuberant calicles are not characteristic of the Montiporæ proper.* They may and frequently do appear in the younger portions of the stock which consist solely of the often thin primitive streaming layer. Out of this they frequently emerge and are then naturally tilted towards the direction of growth. As, however, the corallum thickens, the thickening layer submerges the protuberance so that the calicle comes to open level with the surface of the cœnenchyma. In *Anacropora*, the thickening cortical layer usually remains thin, and those calicles which grow faster than the cortex round the streaming axial strand rise as true protuberant calicles. This protuberance of the calicles, which may sometimes be suppressed (*A. spinosa*), gives the otherwise uniformly cylindrical stems and older branches the knotted appearance of a blackthorn stick.

As these calicles rise above the surface, the radial elements of their walls may become more and more pronounced. And these, when best developed, are frequently seen to be laminate, the same plate occasionally projecting into the polyp cavity as a septum and down the outer wall as a costa. This, it should be especially noted, is best seen in the most protuberant calicles. In those less protuberant, and hence most like the submerged calicles of *Montipora*, the radial laminæ are not visible, and the septa appear, as is typical of *Montipora*, as vertical series of projecting spines.

These points are of great morphological interest and serve to establish the true relationship of *Anacropora* and *Montipora*.

III. DEFINITION OF THE GENUS.

Anacroporæ may therefore be defined as branched Montiporinæ which, owing to the typical divergence of the thin branches at wide angles, tend to form low matted tangles rather than arborescent stocks, and in which many of the calicle walls grow faster than the feebly developed cortical layer, and are thus protuberant; the laminate radial elements typical of Madreporidæ, but lost in *Montipora*, reappear in the protuberant walls as septa and costæ.

IV. RELATION OF THE GENUS TO MONTIPORA.†

Assuming then the close relationship of these two genera, we are, I think, justified in regarding *Montipora* as the more primitive. Its simple explanate method of growth must have preceded the highly specialised branching of *Anacropora*. On the other hand, the protuberant calicles with laminate radial structures suggest that the genus branched off from the common ancestor before the calicles were quite as degenerated, or rather stunted, as they now are in *Montipora*. The markedly laminate character of the axial layer, which is now so frequently

* On the two kinds of false protuberance seen in this genus, see pp. 10–11.

† The inter-relationships of the Madreporidæ set forth in this volume were accepted by Brook (J. Linn. Soc., xxiv. 1893), though from a different morphological standpoint.

a purely filamentous reticulum in *Montipora*, is also a primitive feature retained by *Anacropora* (see p. 13). The living polyps are unfortunately quite unknown. A comparison of them with those of *Montipora* is certainly a desideratum.

V. GEOGRAPHICAL DISTRIBUTION.

So far as the distribution of this genus is yet known, it would appear to belong to the Indo-Pacific intertropical * area. It is known as yet to extend as far north as Macclesfield Bank; it has been taken in the Arafura Sea; while, from west and east, it has come from Keeling Island and from the Solomon Islands.

VI. ON THE CLASSIFICATION OF THE SPECIMENS.

The remarks made in Vol. II. p. 20 on the classification of a small number of specimens hold good here. There are no long and puzzling series. Each type of growth can be described by itself without fear of reproach for needless multiplication of new species.

LIST OF SPECIES OF THE GENUS ANACROPORA.

(An asterisk implies that the species is not represented in the Collection.)

1. forbesi.
2. gracilis.
3. erecta.
4. reptans.
5. solida.
*6. spinosa.

---

1. Anacropora forbesi. (Pl. XXXIV. fig. 17.)

Anacropora forbesi, Ridley, Ann. and Mag. Nat. Hist., xiii. (1884) p. 287, pl. xi. fig. 1.

Description.—Corallum a low, spreading tuft of slender, cylindrical, knotted stems, bent, curved or twisted and fusing irregularly with one another. The stems differ slightly in thickness, 6 to 7·5 mm., but each stem remains fairly uniform throughout its length. Short, bent, horn-like branches come off at irregular intervals and angles. The whole tuft appears to creep along the ground, not rising to any great height.

* Cf. Rep. Voyage Alert, 1884, p. 174.

Calicles as conspicuous holes raised only on slight protuberances, with faintly projecting, sharp margins. The older calicles on the thicker stems may reach 1 mm. in diameter of aperture, while the young calicles appearing near the tips of the branches are about 0·5 mm. The aperture is tilted a little in the direction of growth. The lower side of the projecting margin is often thin and jagged, sometimes a series of points. The septa generally irregularly and feebly developed round the margin, but occur in the fossa in two nearly symmetrically arranged cycles. Lamination of the radial structures only indicated by directives and primaries. The primaries (of which one or two in the direction of growth are larger and thicker as directives) are very short and do not reach to the half radius circle; the secondaries are mere points. Fossa open and deep.

The axial streaming layer of the cœnenchyma is about 2 to 2·5 mm. in diameter and consists of an open arrangement of stout pronounced bands running in the direction of growth. This forms the tapering tips of the branches, and in it the young calicles appear. The thickening of the branches and stems is entirely due to the appearance and growth of the cortical layer. This is in marked contrast to the streaming layer and is very dense, merely traversed by canals which appear as pores or more frequently as furrows gyrating about on the surface. The otherwise smooth surface is frosted over with minute white granules or points.

This species is peculiar in the comparatively slight protuberance of the calicles, and the septa being vertical rows of points, as in *Montipora*, and showing only a slight tendency to lamination, the directives and primary septa being frequently plate-like as if they were parts of interrupted lamellæ.

The two original type specimens upon which the genus was founded by Mr. Ridley in 1884 are in the possession of the Museum.

The larger specimen is a portion of a low straggling stock, some 12 cm. long and rising to about 6 cm. from its dead base. It seems to have been broken into seven pieces, two which have been refixed in their places, while four are still detached. The bases of the stems die down progressively and corrode. Here and there also young branches are dead and corroded.

The smaller is a detached branch which has continued to live, the surface of fracture having been covered over by a growth of spongy cœnenchyma in which young calicles are appearing.

Both these specimens, which are a faint pink colour, are figured in the original paper by Mr. Ridley.

a, *b*. Keeling Islands (deep water inside reef). H. O. Forbes, Esq.
(With four fragments of *a*.)

2. Anacropora gracilis.

Anacropora gracilis, Quelch, Chall. Rep., Reef Corals (1886) p. 170, pl. x. figs. 6, 6*a*.

Description.—Corallum a close tangle of thick stems and branches, the latter not tending to grow upwards but to fuse irregularly together. The component stems and branches of nearly uniform thickness, from 3 to 5 mm., twisted and bent in all directions.

The whole stock has a vertical thickness of about 5·5 cm., of which the upper 4 cm. are living, while in the lower 1·5 cm. the stems are dead and corroded, each stem dying progressively upwards.

The calicles are conspicuous and open, markedly protuberant, the apertures being tilted slightly forwards in the direction of growth; the margin of the aperture often formed by one or more rings of blunt points, which represent the tips of the trabeculæ from which the septa project. Diameter of aperture 0·75 mm. Laminate radial structures of the protuberant calicles may be obscured, but generally traceable. The septa are inconspicuous and irregular, in two cycles, the primaries are very short, with two directives in the line of growth often visible down in the fossa. Fossa open and deep.

The cœnenchyma is differentiated into a delicate open axial reticulum composed of longitudinal laminæ and a thin cortical layer, which is dense as compared with the axial strand, but is open and porous as compared with the cortical layer in *A. forbesi*. Seen from the surface, this layer appears to be a reticulum, densely covered with short blunt echinulæ, which give it a light fragile appearance; the tips of the branches are wholly composed of the axial streaming layer, the laminate elements of which run out as short, blunt, free ends, when seen against the light with a pocket lens.

The type specimen is from Banda. It is a close tangle so that individual stems are soon lost in the repeated fusings; the stock has been bleached. In addition, there are some unbleached (red-brown) specimens from Evans Bank, Arafura Sea. These consist of a fragment —which appears to have been secondarily thickened because its dead base is thin like the type —and of three fragments which are clearly specifically identical with the Banda specimen. The thicker fragment departs somewhat from the type in the greater protrusion of the calicles, and in the greater length of the echinulæ. Further, the radial arrangement of the elements forming the protuberant margins of the calicles is clearly marked. These calicles strongly recall those of a Turbinarian.*

a. Banda (with a fragment). H.M.S. 'Challenger.' (Type.)
b. (Four pieces) Evans Bank, Arafura Sea, 12 fathoms. H.M.S. 'Penguin.'

There is also what appears to be a young specimen of this species. It consists of a single short stem with two divergent prongs, each of which divides again quite irregularly. The specimen appears not to have thickened much, it is only from 3 to 4 mm. thick, and, there being hardly any cortical layer developed, the streaming of the axial strand is seen at the surface and gives a character to the surface reticulum. The calicles are not very protuberant and are smaller, but the tendency of the elements on the lower side of the calyx to arrange themselves radially is quite apparent. Owing to the thinness of the protuberant wall, the primaries form external costæ as well as internal septa.

c. (Young stock ?) Evans Bank, Arafura Sea, 12 fathoms. H.M.S. 'Penguin.'

* See Ann. and Mag. Nat. Hist., xx. (1897) pl. xi. fig. 5.

In addition to the above there are two more small specimens also from Evans Bank, but from a greater depth, viz. 15 fathoms. Radial laminæ are very pronounced in the protuberant calicles. On the lower and more protuberant sides of the calicles, the directive septum, with one or two primaries near it, may rise up as exsert laminæ above the rest of the margin, and even project as jagged costæ down the outer side of the calyx. In these cases there are traces of the spiral twisting of the calicles which was noted here and there in the genus *Turbinaria* (cf. Vol. II. p. 13). Further, in harmony with these pronounced jagged costæ on the calicles, the whole surface of the cœnenchyma is much more coarsely echinulate or granulate.

d. (Two pieces) Evans Bank, Arafura Sea, 15 fathoms. Admiralty. 92. 4. 5. 47.

There is, also from the Evans Bank, a specimen much distorted by re-encrustation. What appears to have been a young stock, or else a detached fragment of an older stock, has been grown over by a layer of fresh coral, about 2 mm. thick, the growing edge being accompanied by an epitheca. A tip of the dead and corroded stock, which has been thus covered up, protrudes, and can be recognised as belonging to this type. That the encrusting layer is of the same coral is a pure assumption. It might, from its structural features, be an encrusting Montipore. It is, however, more probable that it is a re-encrustation of an old stock; the echinulate or granular surface closely resembling that of *A. gracilis*. Further, there are a few protuberant calicles tilted towards the growing points; and, lastly, this encrusting layer sends up pointed processes very like the small tapering branches of *Anacropora*. On the other hand, the facts that many of the calicles are flush with the surface, and that the *interstitial* spaces are here and there raised in papillæ (which, however, may be due to the layer having covered over the knoblike calicles of the dead support), strongly suggest that the growth is a Montipore. On account of my deduction of *Anacropora* from *Montipora*, I incline to look upon this encrusting layer as belonging to the former. A case of re-encrustation is recorded by Rehberg (see *A. spinosa*, p. 176). In the submerged calicles, the radial arrangement of the cœnenchyma is very marked; the flakes standing perpendicular to the surface, and forming the echinulæ, are, round the calicles, arranged radially and project over the aperture, forming the septa which greatly limit the size of the fossa. The specimen is attached to a spherical horny sponge, much encrusted with calcareous algæ. The creeping layer of coral expands slightly over this basal mass, as if to form a fresh attachment.

e. (Encrusted specimen) Evans Bank, Arafura Sea, 12 fathoms. Admiralty.

3. Anacropora erecta. (Pl. XXXIV. fig. 18.)

Description.—Corallum a close tuft of thin, irregularly fusing stems and branches which tend to point upwards. The thicker basal stems are about 5 mm., the younger branches about 3 mm. in diameter.

Calicles raised on slight rounded knobs; aperture small, 0·6 mm., frequently narrow and elliptical, and somewhat inconspicuous. The long diameter of the aperture crosses the direction of growth at right angles, the directive septa coinciding with the short diameter. These septa approach the centre of the fossa; the remaining septa are often very irregular. The

exact character of the radial structures is usually obscured by the solidification of the cœnenchyma round the margin. Interruptedly laminate septa are here and there conspicuous. Parts of two cycles appear; they are often mere spinelike projections of the surface granules into the aperture. In parts where the surface granulation is specially richly developed, the margin and septa may be so frosted over as almost to close the aperture. Well developed primaries may appear club-shaped, i.e. with round and slightly swollen tips.

The axial strand of the cœnenchyma is composed of stout laminæ and is rather dense. The sides of the tips of branches, where it comes to the surface, appear furrowed, the furrows running irregularly upwards. The cortical layer is very dense—indeed, on the thicker stems it is solid. The surface is finely frosted over with granules.

There are three small portions of a stock together with two fragments which originally belonged to larger specimens, from the Solomon Islands, preserved in the Vienna Museum. They approach nearest to *Anacropora gracilis*, but differ in having thinner stems, being slightly more arborescent, and in the much feebler development of the protuberant calicles, and consequent less marked lamination of their radial structures.

a. Solomon Islands. Vienna Museum. (Type.)
b. (In four fragments.) „

4. **Anacropora reptans.** (Pl. XXXIV. fig. 19.)

Description.—Corallum a matted tangle which appears to creep low down along the ground. The thinner stems are about 4 mm., with branches about 3 mm. thick; the older and thicker stems are from 6 to 7 mm. thick. From the younger, thinner stems the branches shoot out nearly at right angles, while the older portions of the stock, consisting of thicker stems, become closely matted, often complicated by the fusion of fragments accidentally broken off and caught among the branches of the stock.

The calicles are not tilted in the direction of growth, but look straight out; they are raised on rounded mammillate swellings which are not conspicuous on the younger, thinner, stems, but, in older and thicker stems, may become nipple-shaped, 1 mm. high and 2 mm. in diameter at the base. The aperture of the polyp-cavity has no distinct margin and no clear fossa, but the protuberances are highly echinulate, and, at the top, six prominent radial septa (frequently laminate) stand up above the rest. These exsert septa are often thicker and stouter than any of the other echinulæ round the margin, and one or two are generally specially developed as directives. The septa are often irregularly disposed, but in symmetrical calicles two cycles can be made out, the second being feebly developed.

The axial streaming layer of the cœnenchyma consists of a loose laminate reticulum, the laminæ so full of large round pores as to make the reticulum appear filamentous. The cortical layer is thin and dense, but is perforated by canals; the surface is densely echinulate and has, to the naked eye, a fine and velvety appearance. The echinulæ are very thin and delicate

in the valleys between the protuberant calicles, but on the sides of these they are longer and coarser, and radiate outwards as flat and erect flakes; these reach a great size in the exsert flakes forming the septa.

There are four specimens: one (*d*) is a long thin stem which gives off a few branches at right angles (a young stock); the other three are older and their thicker stems are matted and fused irregularly. They appear to have lain almost flat on the ground, touching it at several points. The fusion, with the stock, of detached fragments can also be easily detected.

This species differs greatly from any other yet described, and is interesting on account of its creeping method of growth. Its yellow-brown colour is that common to many of the Montipores from the same locality.

a.	Macclesfield Bank, China Sea, 32 fathoms.	H.M.S. 'Egeria.' (Type.)
b, *c*.	„ „ „	Coll. Bassett-Smith.
d.	A thin (? young) stem. „ „	„ „

5. Anacropora solida. (Pl. XXXIV. fig. 20.)

Anacropora solida, Quelch, Chall. Rep., Reef Corals (1886) p. 170, pl. x. figs. 7, 7*a*.

Description.—Corallum consists of stems with open branching at very wide angles, the stem bending away wherever a branch is given off. Stem cylindrical, of very uniform thickness, from 5 to 6 mm. The branches are tapering and thornlike, 4 mm. thick at their bases.

Calicles hardly visible to the naked eye, scattered, raised on very slight eminences, the apertures being faintly tilted in the direction of growth. The aperture may be either sharply circumscribed and more or less symmetrically petaloid, 0·5 mm. in diameter, or else a mere irregular break in the surface without definite shape or symmetry. Parts of two cycles of septa seldom symmetrical, and not, as a rule, developed round the aperture; only down in the fossa can both cycles be seen. The primaries are thick and well developed, lamination being confined to the directives; the secondaries as mere points indenting the rounded outlines of the petaloid interseptal loculi. Even with a pocket lens, the young calicles are difficult to find on the young thornlike branches.

The axial strand of the cœnenchyma is a rather close but delicate reticulum which appears filamentous but is very flaky. The cortical layer is denser, and appears to consist of flakes which are built up on the surface by the formation of granules which branch out over the surface. The frosting of the stems largely consists of these branching flakes parallel to the surface. As the axial strand is never more than 2 mm. in diameter, and gradually diminishes, owing to its progressive solidification from the circumference inwards, the stems are, comparatively speaking, very dense.

There are two fragments of this type, which, but for the method of branching, might be a true Montipore. The calicles are very slightly protuberant, and the lamination of the radial

structures only visible in a few directives, the rest of the septal apparatus being that characteristic of *Montipora*. On the other hand, the method of branching resulting in the stems being apparently bent at sharp angles is characteristic of this genus. In the smaller piece (*b*) the branching is very striking, and is either the result of the fusion of two stems, or else branches may strike backwards, coming off from the main stem at an angle of at least 120°.

a, *b*. Kandavu. H.M.S. 'Challenger.' 85. 2. 1. 11. (Type.)

6. Anacropora spinosa.

Anacropora spinosa, Rehberg, Abh. Nat. Ver. Hamburg, xii. (1892) p. 42, pl. iii. fig. 9.

Description.—Corallum a bushy tuft of tapering stems and branches tending to grow upwards, and without any marked tendency to fuse together. Height as much as 18 cm., branches, at base, 1 cm. thick. The branches are curved, with spinous processes (3 to 10 mm. long) branching off at an angle of 80°. Tips of branches tend to curve backwards.

Calicles hidden behind the spinous processes and hence not visible at first sight; only a few here and there are free and exposed; scattered, very small, 0·24 to 0·3 mm.; two cycles of spinous septa; the primaries tapering toward the centre of the fossa, the secondaries for the most part very feebly developed. A columella-like structure visible in the base of the fossa.

In section, the cœnenchyma is porous; in the older part of the stem it becomes denser. The surface is closely and sharply granular.

In addition to this description, Dr. Rehberg adds that the coral partially covers by encrustation the dead portions of its own stock, and that the colour is yellowish. In giving the size of the calicles, the author wrote, "·24 to 0·30 cm.," which would certainly not be "very small." I have felt justified, therefore, in changing the unit of measurement into millimetres.

The chief claim which this has to be an Anacropore lies in the angular character of its branching. The submerged character of the calicles, with their stunted septal apparatus, shows that it undoubtedly belongs to this Montiporine subfamily. But it appears to lack most of the special characters of *Anacropora*. Its large size, its arborescence, the absence of the protuberant calicles, are against classifying it here. On the other hand, the small size of the calicles may be a secondary acquirement resulting in the absence of protuberance.

There is, unfortunately, only one specimen known, from the Pelew Islands. It is stated to be preserved in the Hamburg Museum.

APPENDIX TO THE GENUS MONTIPORA.

WHILE the foregoing pages were passing through the press, two small collections of Montipores, one from Funafuti, made by Mr. J. Stanley Gardiner, and the other from the Loyalty Islands, made by Mr. Arthur Willey, were kindly sent me by Mr. Gardiner, of Gonville and Caius College, Cambridge, for inspection, in order that I might be able to incorporate any fresh types in this Catalogue. Their examination has resulted in seven new species, the type specimens of which remain, thanks to Mr. Gardiner's kind permission, the property of the British Museum. I am also indebted to Mr. Gardiner for the information he has given me regarding the colours of some of these corals when alive.

a. Foveolate.

136. **Montipora pilosa.**

Description.—Corallum closely encrusting, without free edges, 3 mm. thick.

Calicles minute, 0·3 mm., but comspicuous, because sunk in the hollows between interstitial ramparts, margin not circumscribed, irregularly distributed, 1 to 2 mm. apart. Two cycles of septa, irregularly developed. One directive interruptedly laminate, exsert and sometimes continued up the sides of the interstitial rampart.

Cœnenchyma shows in section a very stout laminate reticulum, resting on the epitheca. The surface rises evenly above the level of the calicles; the depressions for the calicles are distinct, round and funnel-shaped, about 1 mm. in diameter and 0·5 mm. deep. The surface texture consists of very fine flakes, standing up and twisted in all directions; to the naked eye it appears soft and hairy.

There is only one specimen of this coral, a small encrusting patch, 6 cm. across; its surface is very irregular, owing to the unevenness of the substratum. One side was evidently being killed by other organisms. In general appearance and in its apparently woolly texture it approaches *M. mollis*, but on closer comparison the two are seen to differ widely. The calicles of *M. mollis* are larger, closer together, have much more pronounced septa, and are not so deeply and definitely immersed as they are in this specimen.

*a.** Sandal Bay, Lifu, Loyalty Islands. Coll. Willey. (Type.)

* This specimen is further valuable because underneath it are the three earliest known stages in the growth of *Alveopora*.

137. Montipora profunda.

Description.—Corallum, complete form unknown, massive, with drooping and creeping edges in close contact with the substratum ; a well developed epitheca projecting slightly beyond the cœnenchyma.

Calicles conspicuous, circular, slightly less than 1 mm. diameter, sunk deeply in the pits formed by interstitial ramparts, septal apparatus symmetrical, in two cycles evenly developed, the primaries reaching to near the half radius circle, the secondaries being about half the size. Calicles very deep, running straight down through the corallum, showing in vertical section long straight series of interruptedly laminate septa, much more developed than near the aperture, and with slightly swollen free edges. Minute developing calicles are found here and there at the angles where the thick interstitial ramparts meet.

Cœnenchyma in section a pure reticulum streaming continuously upwards, compact, but getting looser nearer the surface. At the surface the interstitial ramparts swell up evenly into thick ramparts, which consist of closely packed flakes, perforated so as to form a laminate reticulum with fine irregular echinulæ rising up from its surface. On the drooping sides the ramparts rise irregularly, making the surface uneven.

This massive coral belongs to the foveolate group and should be associated with *M. foveolata* and *M. turgescens*. The calicles have the same circular outline and symmetrical septal apparatus. The septa are, however, rather thinner and more prominent, and the ramparts more evenly rounded, and the surface reticulum is more delicate.

a, b. Funafuti, Ellice Island. Coll. Gardiner. (Types.)

Montipora caliculata, var. piriformis.

[For description, see pp. 57–59.]

Under this heading a pear-shaped stock, from the Solomon Islands, rising on a stalk of corroded coral, down which it was creeping, is described in the text. It shows the foveolate specialisation of the cœnenchyma, but the calicles are very much smaller than in *M. foveolata*, and further they rise in considerable numbers, surrounded by circular walls. This character seemed to ally the specimen with *M. caliculata*.

There are in the Cambridge University Museum two large, very massive stocks, from Funafuti, with more or less smooth rounded tops and thick perpendicularly drooping edges. They closely resemble the specimen above described. The larger specimen of the two actually approaches the pear-shape. The chief difference appears to lie in the size of the calicles, which are larger than in the specimen from the Solomon Islands. I am not disposed to lay much stress on this in view of the facts (1) that the calicles have the same general character, both alike resembling the calicles of *M. foveolata*, with their symmetrical rings of twelve short septa and open fossa ; (2) that the calicles in *M. foveolata* vary greatly in size, in some specimens surpassing the calicles of all other known Montipores.

It becomes more and more clear to me that the simple surging up of the interstitial cœnenchyma above the level of the calicles, so as to form protecting ramparts round the polyps, i.e. foveolation, has been a very successful specialisation. It has certainly been developed in a great number of Montipores, but with shades of difference which effectually baffle the systematist. The attempt here made to group the specimens which show this character into species and varieties must be regarded as purely provisional, until longer and more complete series are at hand.

b. Papillate.

138. Montipora alveopora.

Description.—Corallum is tall and roughly conical, the cone standing on its apex, and built up by tiers of smaller solid cones, each tier starting from the platform made by the fused tops of those forming the underlying tier. While some of the spaces between the individual cones persist in the heart of the stock, all traces of the separate cones are obliterated externally, except on the uppermost platform where the new tier is forming. Here the cones which rise up and fuse to form the next platform are seen to spring up from among a great number of irregular digitiform processes.

Calicles on the sides small, 0·5 mm., uniform, inconspicuous, evenly distributed about 1 mm. apart, margin generally sharply circumscribed but irregular in shape, and with part of two cycles of short septa, the primaries only just distinguishable from the secondaries. On the flat tops of the rising cones the calicles are crowded in valleys between the surging papillæ, and are then separated merely by their angular membranous walls, with a few irregular septal spines. They strongly resemble the calicles of the genus *Alveopora*.

The cœnenchyma consists of a friable, delicate and very porous laminate streaming layer which carries the coral upwards. This forms the floors of the platforms, and, by bending outwards horizontally with very little change, the sides of the cones and of the other rising processes. On the sides of the cones, and especially near the tapering tips of the digitiform processes, the cœnenchyma rises up to form very irregular underlips, which are without any sharp outlines, and are mere confused projections generally associated with the lower margins of calicles. The surface is either formed of an open reticulum formed by the jagged ends of the streaming layer, or as on the sides of the coral, a system of flakes formed secondarily parallel to the surface. This gives the sides a rather solid appearance and surrounds the calicles with continuous solid-looking rims. The lower portions of the coral do not appear to solidify; numerous fragmentary horizontal membranes, "tabulæ," appear periodically, marking the withdrawal of the living tissue from the lower parts of the skeleton.

The type specimen is part of a stock, the rest being in the Cambridge University Museum. It stands 18 cm. high, and shows traces of three successive tiers of inverted cones each about 6 cm. high. The coral had been broken from its base, the place of fracture being some 4 to 5 cm. across. Thus it is possible that one more tier consisting of but one or two cones had preceded those which composed the specimen.

The existence of these peculiar growth-forms strengthens my conviction, based originally upon the great plasticity of the cœnenchyma (see Introduction, p. 2), that this genus will one day prove to be one of the richest in species of all the stony corals. In the meantime, however, we want rather series showing the history of the different stocks and their possible variations, than new isolated specimens.

The coral, of a brilliant green colour, is from Sandal Bay, Lifu.

a. Sandal Bay, Lifu. Coll. Willey. (Type.)

139. Montipora saxea.

Description.—Corallum encrusting or massive, with nearly even, rounded, slightly pitted surface.

Calicles minute, 0·5 mm., very numerous and evenly distributed, and in two forms. (*a*) In the thinner encrusting specimens, the margin is clear and round, sharply circumscribed, with two cycles of very minute septa, just distinguishable into primaries and secondaries, but with two very conspicuous directives which stand up conspicuous to the naked eye as exsert plates, knobs or spines, very irregular in shape and reaching to about the half radius circle. (*b*) In massive growths, the calicles are not sharply defined, and only the primaries rise to the surface, the secondaries appearing only below the margin. The two large directives are just as irregular but are not so conspicuous.

The cœnenchyma very soon (5 mm. below the surface) becomes quite solid and stony; from this the threads of the reticulum rise up as thin, densely packed, hardly distinguishable trabeculæ. At the surface the cœnenchyma surges up, but quite irregularly, rising up into small pimples but without any definite association with the calicles, sometimes lifting them, sometimes tilting them, sometimes merely raising the interstitial spaces. The surface textures consist of the loose ends of the reticular threads pointing in all directions; in encrusting specimens it is dense, but in the massive specimens it is open, the threads branching above the surface.

There are two specimens of this coral, which is distinct from any hitherto described. One is an encrusting form about 1 cm. thick, the free edges of which have been unfortunately broken away, and the other is a fragment chipped out of a massive block. Close examination shows that the former of these must have flaked off from a massive block over which it was apparently creeping. Both are much perforated by boring bivalves, which apparently live with the coral, keeping their siphons above its surface. The encrusting specimen is full of small calcareous worm-tubes which open near the calicles flush with the surface. (Cf. *Astræopora gracilis*, vol. ii. p. 93). In life, the colour varies from purple to violet.

In the irregular character of the papillæ this coral reminds one of *M. guppyi*, while in the size of the calicles and in the two conspicuous exsert septa it resembles the purely glabrous species *M. exserta*. The name was suggested by the sudden solidification of the cœnenchyma 5 mm. below the surface, so that it builds up masses of solid rock, in which may be incorporated other corals which happen to come in the way of its growth. The corroded remains of a *Pocillopora* are seen in the larger of the two type fragments.

a, *b*. Funafuti, Ellice Islands. Coll. Gardiner. (Types.)

c. Tuberculate.

Montipora incognita.

[For description, see p. 131, also Pl. XXIV. fig. 1.]

There are six fragmentary specimens in the Museum of the University of Cambridge which appear to be very closely allied to the single type specimen in the National Collection. Four of them are parts of fronds and two are nodules. The largest frond is 14 cm. deep. In the general aspect of the surface the specimens closely resemble one another and the British Museum specimen, the calicles being somewhat obscured by the ragged tubercles. Again, the under surface is frequently free from epitheca, smooth and stony, with the same gyrating fissures. But only on one specimen is there any indication on the under surface of the protrusions of the cœnenchyma, and then they are not more than incipient drops and not the long pointed cones of the type specimen in the British Museum. Lastly, all have the same tendency of the cœnenchyma to form a light, delicate, foam-like reticulum, a laminate streaming layer, and flame-like tubercles.

The most conspicuous differences are the following:—The calicles in the Cambridge specimens are somewhat smaller, wider apart, and more sharply circumscribed; on the nodules they are surrounded by protuberant membranous walls. The septa are in two cycles, the directive being interruptedly laminate. In the type specimen the septa are only thin spines.

The tubercles, though having in general the same ragged flame-like appearance, are much more uniform in the type specimen. In the Cambridge specimens they vary greatly in size and distribution. They are more associated with calicles as palisades of smooth glassy rods or plates, the edges of which alone are frayed out, whereas in the type not only the edges of the rods and plates but the sides also are covered with fine points.

In spite of these striking differences I feel justified in associating these corals with the type, firstly because the six Cambridge specimens vary greatly among themselves according to their different growth-forms, and the nearer the form of the fragment is to that of the type specimen the closer is the resemblance; secondly, because the type specimen is much older and thicker, and some of the differences might be thus explained. The older and thicker stock might have slightly larger and thus more crowded calicles; the thicker the cœnenchyma, the more certainly would the smoother portions of the tubercles be submerged until only their ragged tips and edges appeared above the surface. This last point, however, is not very important, owing to the extraordinary variability in the fine surface texture on different parts of one and the same specimen.

These corals, like the last, are from Funafuti, Ellice Islands, and also vary in colour from purple to violet.

140. **Montipora myriophthalma.**

Description.—Corallum, complete form unknown, encrusting, thick, 6 to 7 mm., irregularly crumpled and folded round former growths, so as to form irregular nodules. An epitheca close under the thick, round, creeping edge.

Calicles very conspicuous, the apertures being surrounded by close rings of short, round

tubercles; actual aperture 0·75 mm., the diameter of the ring of tubercles 1·5 mm. Irregularly distributed but generally less than one diameter apart. Each ring of tubercles being in contact with another ring. Twelve nearly equal symmetrical septa, which are short and thick, but wedge-shaped seen from above. Two more massive directives often interruptedly laminate. Tubercles rise straight above the peripheral ends of septa, there being no proper margin to the calicle aperture. Fossa open and deep. Well formed calicles seen right round the face of the growing edge up to the border of the epitheca.

Cœnenchyma shows in section a thick, solid layer resting on the epitheca and extending almost to the growing edge; the streaming layer is thus very early obscured, the actual edge itself being apparently formed of outwardly curving trabeculæ, projecting from the solid layer. This latter varies from 1 to 1·5 mm. thick, and upon it rest the densely packed trabeculæ which are stout, 0·5 mm. thick, but taper somewhat near the surface, so that the tubercles arising from them are small, 0·25 to 0·3 mm. in diameter. The tubercles are arranged in low regular rings round the calicles, remaining distinct, round, frosted or bushy, and from 8 to 9 in each ring. They rise less than 0·5 mm. above the surface, but are conspicuous owing to their whitish frosting. The interstitial spaces are smooth and slightly concave, their floors, however, are composed of the rounded tops of closely packed but distinct tubercles. One or two may occasionally rise, but do not reach to the level of the top of the rings.

This description is based upon what appears to be the normal portion of a specimen, part of which is reflexed and consequently greatly distorted. The conspicuous ringed calicles, with smooth concave interstitial spaces, are peculiar features. The whole of these characters, however, are lost on a portion of the fragment which is folded round under two thick layers so as to form a nodule. The tubercles here all rise up thickened, fused into plates and crowded together, so that the calicles, which are also very crowded, are sunk deeply down below the surface formed by the tops of the tubercles.

This specimen, though only a fragment, is separately described on account of the peculiar arrangement of the tubercles. It is possible that if the complete stock were known it might be allied with one of the existing species. The uniformity in shape and size of the tubercles surrounding the calicles places it near the æqui-tuberculate group, *M. peltiformis*, *M. granulata*, and *M. æqui-tuberculata*.

a. Sandal Bay, Lifu, Loyalty Islands. Coll. Willey. (Type.)

141. Montipora granifera.

Description.—Corallum, complete form unknown, encrusting, 5 mm. thick.

Calicles crowded, conspicuous, sunk among the forest of tubercles. Two cycles of septa, thin, symmetrical, primaries twice as long as secondaries, two directives reach to the half radius circle. The tubercles rise straight over the peripheral ends of the septa, there being no proper margin to the calicle. Fossa open and deep.

Cœnenchyma shows in section a thin, finely reticular streaming layer, resting on the epitheca. From this, trabeculæ arise, long, stout, not too compact, joined by thick, irregular junctions, which are in marked contrast with the thin septa, also seen in sections. The trabeculæ rise as round-topped tubercles, fairly uniform, and ending all on the same level. Those arranged as rings (7 to 8 in each) round the calicles, are slightly larger and taller. On raised portions of the surface, the tubercles are more solid and plate-like, densely packed and fusing together to form a continuous even surface, while in depressions they are thinner, more thread-like, and distinct.

The type specimen is a fragment from Funafuti, also one of the æqui-tuberculate group. While approaching both *M. granulata* and *M. myriophthalma* it cannot be united specifically with either—that is, without more evidence. It differs from *M. granulata* in not having the free trabeculæ, nor the sharp contrast between the thick streaming layer of delicate reticulum and the pronounced trabeculæ, and further in the distribution and size of the calicles.

From *M. myriophthalma* it differs in the absence of the solid layer, in the shape of the trabeculæ, and in the character and distribution of the calicles.

a. Funafuti, Ellice Islands. Coll. Gardiner. (Type.)

142. Montipora willeyi.

Description.—Corallum explanate, encrusting, with narrow, free, but drooping or pendent and hence somewhat crumpled edges which are very friable and vary greatly in thickness from 2 to 7 mm. Whole surface of the coral raised into irregular mounds by the unevenness of the substratum. Thickness of encrusting layer very variable, average 6 mm. An epitheca supports the thinner edges but remains behind under the thicker, more friable edges.

Calicles about 0·75 mm., irregularly distributed in a network of lines, the calicles in the lines being almost in contact, the clear spaces being sometimes 2 to 3 mm. across. Two cycles of septa, symmetrical but very short and insignificant round the margin, better developed down in the deep, open, funnel-shaped fossa. Most of the calicles appear as if raised and slightly tilted towards the growing edge, while near to the edge itself they frequently stand up a little with an irregularly protuberant proximal wall. The calicles first appear on the friable edges, and are at first only distinguishable from meshes of the laminate reticulum by their circular form. Those which bend downwards towards the lower surface become more and more conspicuous as membranous rings until they are corroded by the epitheca.

The cœnenchyma consists of a streaming layer, the laminæ of which, while distinct enough to make a clear line pattern at the growing edge, are yet so perforated that the longitudinal section appears filamentous. It varies greatly in thickness and is generally very thick, but soon solidifies upon the epitheca, and from the solid layer thus formed, which may be 3 or more mm. thick, a dense trabecular layer rises; the trabeculæ are very

variable, being here hardly more than reticular threads, there stout rods rising above the surface as tubercles. The tubercles are usually associated with calicles; but only here and there do they form protuberant rings (of 5 to 6), for the most part one or two rise directly from the calicle margin, either at the side so as faintly to suggest longitudinal series, or proximally so as slightly to tilt the calicle aperture. The suggestion of series is further enhanced by the occasional presence of rows of much smaller tubercles in the depressed interstices, while round the edges, where no tubercles are formed, there is a faint ridging of the surface.

The type specimen is interesting because it is encrusting a massive almost solid block some 3 cm. thick which has all the appearance of being formed by the same coral. The section of this block, which progressively solidifies below, suggests the possibility of the trabeculæ continuing to grow almost indefinitely. Massive stocks are built up by *M. solida*, *M. rotunda*, *M. verrucosa*, *M. alveopora*, and *M. saxea*. Of these, the second and last show tendency to progressive solidification. This is the only known tuberculate Montipore I can call to mind which shows the same phenomenon.

With regard to the affinities of the specimen, I was at first disposed to class it with *M. listeri* (p. 122). The two specimens have much in common, but the one is a free thin frond, and the other a closely encrusting layer. It seemed at first sight possible to explain most of the differences as due to this difference in growth, as a comparison between the free fronds of *M. plicata* with the nodulated crumpled leaves of the same, amply showed. All that I am now prepared to say is, that this specimen *may be* an encrusting specimen of *M. listeri*—that is, the range of variation does not preclude the idea—but there is absolutely no evidence. Further, it is clear that we can have no evidence until freely expanding fronds of this coral closely associated with encrusting layers, or, what would be equally good, until encrusting layers of *M. listeri* are discovered. Again, then, we must wait for longer series.

a. Sandal, Lifu, Loyalty Islands. Coll. Willey. (Type.)

Postscriptum to first footnote on p. 4.

Ehrenberg, on p. 121, includes Montipora Q. & G. as one of the many genera and generic names "quæ physiologicis characteribus destituuntur," and " = Madrepora."

INDEX OF GENERIC AND SPECIFIC NAMES.

[Figures in black type refer to pages on which the descriptions will be found.]

abrotanoides (Madrp.), 110.
—— (Montp.), 84, **110**, 112.
acanthella (Montp.), **79**.
ænigmatica (Montp.), **73**.
æqui-tuberculata (Montp.), **130**, 182.
alcicornis (Montp.), **43**, 47, 60.
alveopora (Montp.), **179**, 184.
ambigua (Montp.), 74, **107**.
amplectens (Montp.), **143**.
angulata (Montp.), **63**, 133.
—— (Porites), 5.
angulosa (Porites), 133.
annularis (Montp.), **115**.
aspera (Montp.), 84, **139**.
auricularis (Montp.), **30**.
australiensis (Montp.), **95**, 142, 153, 155.

bilaminata (Montp.), **80**, 143.
bifrontalis (Montp.), **165**.
bolsii (Montp.), 20, **34**, 35, 121.
brueggemanni (Montp.), **74**, 110.

cactus (Montp.), 36, **118**, 130.
calcarea (Montp.), 43, **59**, 165.
caliculata (Manopora), 57.
—— (Montp.), 10, 14, **57**, 60, 66, 71, 178.
capitata (Manopor.), 103.
—— (Montp.), 104.
challengeri (Montp.), **121**.
circinata (Montp.), **155**.
circumvallata (Manopora), 87.
—— (Montp.), 85, **87**, 137.
—— (Porites), 87, 137.
cœrulea (Montp.), 69, 70.
complanata (Montp.), 5, **29**, 32.
—— (Porites), 5, 29.
compressa (Manopora), 14, 42.
—— (Millepora), 4, 14, 42.
—— (Montp.), 4, **42**, 47, 68.
contigua (Madrp.), 133.
crassifolia (Montp.), 156, **162**.
crassireticulata (Montp.), **27**.
crassituberculata (Montp.), 114, **141**.
crista-galli (Manopora), 84, 139.
—— (Montp.), 78, **84**, 87, 110.
—— (Porites), 84.

danæ (Montp.), 76, **101**, 104, 112.
denticulata (Montp.), 89.
digitata (Montp.), 41, 44, **47**, 48, 52, 61, 65.
divaricata (Montp.), **39**, 61.

edwardsi (Montp.), **78**, 85.
efflorescens (Montp.), **150**.
effusa (Manopora), 144.
effusa (Montp.), **44**, 99, 120, 122.
ehrenbergi (Montp.), 158.
ellisi (Montp.), 10, 15, **149**, 151.
erecta (Anacrp.), 168, **173**.
erosa (Manopora), 35.
—— (Montp.), **35**.
exesa (Montp.), 158, 161.
exigua (Montp.), **20**, 34, 35, 121.
expansa (Montp.), 7, **131**, 132.
—— (Manopora), 131.
explanata (Montp.), **23**, 29, 69, 70, 113.
exserta (Montp.), 6, 29, **31**, 180.

fimbriata (Montp.), **151**.
flammans (Montp.), **76**, 102.
foliosa (Madrp.), 152, 158.
—— (Manopora), 158.
—— (Montp.), 7, 9, 48, 94, 117, 124, 139, 141, 150, 166.
—— (Porites), 136.
forbesi (Anacrp.). 168, **170**, 172.
—— (Montp.), 45, 46.
foveolata (Manopora), 54.
—— (Montp.), **54**, 58, 98, 103, 178.
fragilis (Montp.), 67, **139**.
fragosa (Montp.) 13, **111**.

friabilis (Montp.), **138**, 165.
frondens (Montp.), **147**.
fruticosa (Montp.), **44**, 52.
fungiformis (Montp.), **80**, 97.

gaimardi (Montp.), 43, 46, 47, 52, **64**.
gemmulata (Manopora), 88.
—— (Montp.), 6, 57.
—— (Turb.), 57.
glabra (Montp.), 29, **32**.
gracilis (Anacrp.), 168, **171**, 173.
—— (Astræopr.), 180.
—— (Montp.), **85**, 87.
grandifolia (Montp.), 158, 161.
granifera (Montp.), **182**.
granulata (Montp.), 112, **129**, 141, 183.
granulosa (Montp.), **21**.
grisea (Montp.), **123**.
guppyi (Montp.), **82**, 180.

hirsuta (Montp.), 60 **164**.
hispida (Manopora), 134.
—— (Montp.), 5, 71, 111, **134**, 140, 151.

incognita (Montp.), **131**, 181.
inconspicua (Montp.), 34, **121**.
incrassata (Manopora), 54.
—— (Montp.), 55.
incrustans (Montp.), **119**.
indentata (Montp.), 14, 63, **65**.
informis (Montp.), **133**.
irregularis (Montp.), **60**.

lanuginosa (Montp.), **75**, 77.
levis (Montp.), **41**, 45, 66, 67.
libera (Montp.), **52**.
lichen (Manopora), 23, 125.
—— (Montp.), 25, 57, **125**.
lichenoides (Montp.), 94, 158.
lima (Agaricia), 3, 158.
—— (Montp.), 84, 93, 125, 158, 160.
limitata (Madrp.), 68.
—— (Montp.), **68**.
listeri (Montp.), **122**, 183.
lobulata (Montp.), 76.

mæandrina (Montp.), **100**.
—— (Porites), 100.
mammillata (Montp.), 36, 113, **117**.
mammifera (Montp.), **108**.
marenzelleri (Montp.), **51**.
minuta (Montp.), 92, 93, **124**.
mollis (Montp.), **40**, 177.
monasteriata (Madrp.), 137.
—— (Montp.), 39, 71, 87, 100, 101, **137**, 138, 141.
monticulosa (Montp.), 134, 136.
multilobata (Montp.), 5, 78, 79, 87.
multiformis (Montp.), 14, **61**, 63, 66.
myriophthalma (Montp.), **181**, 188.

nana (Montp.), **47**.
nodosa (Montp.), **117**.
nudiceps (Manopora), 110.

obtusata (Montp.), 3, **33**, 34, 39, 103, 104.

pallida (Montp.), **27**.
palmata (Manopora), 66.
—— (Montp.), 41, **66**, 140.
papillosa (Agaricia), 3, 88.
—— (Manopora), 88.
—— (Montp.), 9, 73, 74, **88**, 89, 95.
patinæformis (Madrp.), 97.
—— (Montp.), **97**, 98, 99, 117.
patula (Montp.), 128, 144.
perforata (Montp.), 23, 70, **113**.
peltiformis (Montp.), 60, 112, **128**, 130, 144, 182.
phrygiana (Madrp.), 64, 133.
—— (Montp.), 5, 63, **133**.
pilosa (Montp.), **177**.
piriformis (Montp.), **59**.
planiuscula (Montp.), **99**.
plicata (Montp.), **163**, 184.
poritiformis (Montp.), 64, 65.
porosa (Montp.), 10, **25**, 26.
profunda (Montp.), **178**.
prolifera (Montp.), 91, 92, **93**, 94, 96, 98, 124, 125, 142, 158.
prolifica (Montp.), 91, 93.
pulcherrima (Montp.), **91**, 93, 124.
punctata (Montp.), **28**.

quoyi (Montp.), 5, 54, 104.

ramosa (Montp.), 45, 48, **49**.
reptans (Anacrp.), 168, **174**.
reticulata (Montp.), **26**.
rigida (Montp.), 42, **68**.
rosacea (Montp.), 158.
—— (Porites), 3, 158.
rotunda (Montp.), **50**, 184.
rubra (Alveopr.), 45.
—— (Montp.), **45**, 65, 67.
rus (Madrp.), 140.
—— (Montp.), 35, 39, 100, 117, **140**.

saxea (Montp.), 80, **180**, 184.
scabricula (Manopora), 113.
—— (Montp,), 7, 23, 69, 70, **113**, 115, 146.
scabriculoides (Montp.), 6, 31, 32.
scutata (Montp.), **127**, 133.
sinensis (Montp.), **109**, 112.
socialis (Montp.), **56**, 98.
solanderi (Montp.), 124, 125, 150, 151, **152**, 155, 156, 158.
solida (Anacrp.), 168, **175**, 184.
—— (Montp.), **35**, 38, 118.
spatula (Montp.), **50**.
spicata (Montp.), **45**.
spinosa (Anacrp.), 167, 169, 173, **176**.
spongiosa (Montp.), **86**.
—— (Porites), 86.
spongodes (Montp.), 31, 36, **37**.
spumosa (Manopora), 71, 134.
—— (Montp.), 40, **71**, 98, 135, 151.

spumosa (Porites), 3, 71.
stalagmites (Montp.), 6, **87**, 126.
stellata (Montp.), **120**.
stilosa (Montp.), **115**.
—— (Porites), 115.
stratiformis (Montp.), **22**.
striata (Montp.), 95, 142, **154**.
stylosa (Montp.), 110, 115, 150.
subtilis (Montp.), **21**.
superficialis (Montp.), **46**, 65.

tenuissima (Montp.), **24**.
tortuosa (Manopora), 48.
—— (Montp.), **48**.
trabeculata (Montp.),134,**148**.
tuberculosa (Manopora), 182.
—— (Montp.), 9, 69, 75, 109, **112**, 119.
—— (Porites), 3, 101, 112.
tuberosa (Montp.), **136**, 138.
turgescens (Montp.), **53**, 58, 178.

undata (Montp.), **98**.
variabilis (Mont.), **114**.
venosa (Manopora), 69.
—— (Montp.), 23. **69**.
—— (Porites), 69, 71.
verrucosa (Manopora), 103.
—— (Montp.), 3, 5, 6, 7, 14, 33, 36, 54, 55, 69, 74, 100, **103**, 108, 138, 184.
—— (Porites), 3, 33, 55, 103.
villosa (Montp.), **116**.
viridis (Montp.), 97, **99**, 166.
willeyi (Montp.), **183**.

EXPLANATION OF THE PLATES.

PLATES I.–XXX.

[Collotype reproductions of photographs.]

PLATE I.

FIG.

1. The Type specimen of *M. stratiformis*, × $\frac{2}{3}$, seen from above.
2. „ „ *M. granulosa*, × $\frac{2}{3}$, seen from above.
3. „ „ *M. explanata*, × $\frac{2}{3}$, seen from above.
4. One of the specimens (*b*) of *M. porosa*, × $\frac{2}{3}$, seen from above.
5. Type specimen of *M. tenuissima*, × $\frac{4}{5}$, seen from above.
6. „ „ *M. reticulata*, × $\frac{2}{3}$, seen from above.

PLATE II.

1. The Type specimen of *M. auricularis*, × $\frac{2}{3}$, seen from above.
2. „ „ *M. pallida*, × $\frac{2}{3}$, seen from above.
3. „ „ *M. punctata*, × $\frac{2}{3}$, seen from above.
4. „ „ *M. exserta*, × $\frac{1}{2}$, seen from above.
5. „ „ *M. crassireticulata*, × $\frac{2}{3}$, seen from above.
6. „ „ *M. bolsii*, × $\frac{1}{2}$, from the side.

PLATE III.

1. One of the Type specimens (*b*) of *M. mollis*, × $\frac{2}{3}$, from the side.
2, 3. Specimens (*b*, *c*) of *M. spongodes*, × $\frac{1}{2}$, from the side.
4. The Type specimen of *M. divaricata*, × $\frac{2}{3}$, from the side.
5. „ „ *M. compressa*, × $\frac{5}{8}$.

PLATE IV.

1. The Type specimen of *M. solida*, × $\frac{2}{3}$, from the side.
2. Specimen (*a*) of *M. fruticosa*, × $\frac{1}{2}$, from the side.
3. The Type specimen of *M. spatula*, × $\frac{1}{2}$, from the side.
4. „ „ *M. rotunda*, × $\frac{3}{4}$, from the side.
5, 6. Specimens (*c*, *a*) of *M. gaimardi*, × $\frac{2}{3}$, the latter (*a*) with one side smooth.

PLATE V.

1, 2, 3. Specimens (*a*, *b*, *c*) of *M. ramosa*, × $\frac{1}{2}$, from side.
4. Type specimens of *M. socialis*, × $\frac{2}{3}$, slightly tilted.
5. „ „ *M. indentata*, × $\frac{4}{5}$.

PLATE VI.

FIG.

1. On the left an encrusting specimen (*c*) of *M. fovcolata*, seen from above, and on the right an excrescence from an old stock (*b*), seen from the side, × ¾.
2. One of the Type specimens of *M. turgescens*, × ⅔, from above.
3. The Type specimen of *M. libera*, × ⅔, from above.
4. One of the free stocks of *M. multiformis*, × ¾, from the side.

PLATE VII.

An old stock of *M. multiformis* built up by repeated encrustations, from the side, × ⅔.

PLATE VIII.

1. The specimen *a* of *M. spumosa*, × ½, most nearly resembling Knorr's original figure (see text, p. 71).
2. The Type specimen of *M. ænigmatica*, × ⅔, from above.
3. „ „ *M. edwardsi*, × ½, from the side.

PLATE IX.

A large explanate specimen (*a*) of *M. caliculata*, × ½, from above.

PLATE X.

The Type specimen of *M. calcarea*, × ½, slightly tilted.

PLATE XI.

A very old towering stock of *M. spumosa*, × ⅓, specimen *g*.

PLATE XII.

1. The Type specimen of *M. acanthella*, × ½, slightly tilted.
2. „ „ *M. fungiformis*, × ½, slightly tilted.

PLATE XIII.

One of the Type specimens (*b*) of *M. lanuginosa*, × ½, slightly tilted.

PLATE XIV.

The Type specimen of *M. lobulata*, × ½, from above.

PLATE XV.

The Type specimen of *M. guppyi*, × ⅔.

PLATE XVI.

FIG.

1. Specimen (*b*) of *M. lobulata*, × $\frac{2}{3}$, from above.
2. The Type specimen of *M. bilaminata*, × $\frac{2}{3}$, from above.
3. „ „ *M. tubifera*, × $\frac{3}{4}$, from above.

PLATE XVII.

1. The Type specimens of *M. denticulata*, × $\frac{2}{3}$, from above.
2. Two fragments of the Type specimen of *M. pulcherrima*, × $\frac{2}{3}$, from above and from below.
3. The Type specimen of *M. australiensis*, × $\frac{1}{2}$, slightly tilted.

PLATE XVIII.

The Type specimen of *M. prolifera*, × $\frac{2}{3}$, from above.

PLATE XIX.

1. Part of an old stock of *M. mœandrina*, × $\frac{3}{4}$, from the side.
2. A massive growth of *M. verrucosa*, × $\frac{1}{2}$, from above, specimen *d*.
3. The Type specimen of *M. sinensis*, × $\frac{1}{2}$, from above.

PLATE XX.

A complete stock of *M. danæ*, × $\frac{2}{3}$, which has covered over a large stock of *M. flammans*, a small portion of which protrudes near the centre.

PLATE XXI.

1. The Type specimen of *M. ambigua*, × $\frac{1}{2}$, from above.
2. „ „ *M. undata*, × $\frac{1}{2}$, from above.
3. „ „ *M. perforata*, × $\frac{2}{3}$, from above.
4. „ „ *M. mammillata*, × $\frac{2}{3}$, from above.
5. „ „ *M. cactus*, × $\frac{2}{3}$, from the side; the stock was attached above on the right to a Madrepore.

PLATE XXII.

1. The Type specimen of *M. challengeri*, × $\frac{2}{3}$, from above.
2. „ „ *M. scutata*, × $\frac{2}{3}$, from above.

PLATE XXIII.

1. The Type specimen of *M. peltiformis*, × $\frac{1}{2}$, from the side, growing across the tips of the branches of a Madrepore.
2. The same, from above.
3. Specimen (*d*) of *M. minuta*, × $\frac{3}{4}$, from above.
4. The Type specimen of *M. annularis*, × $\frac{3}{4}$, from above.

PLATE XXIV.

FIG.
1. The Type specimen of *M. incognita*, × ½, from above.
2. „ „ *M. friabilis*, × ½, from the side.

PLATE XXV.

1. The Type specimen of *M. crassituberculata*, × ⅔, from above.
2. Specimen (*b*) of *M. effusa*, × ⅔, the axis of each branch occupied by one or more worm-tubes with thick stems; cf. thin-stemmed specimen, Pl. XXVII.

PLATE XXVI.

A large stock of *M. hispida*, × ⅔, with convex basal expansion.

PLATE XXVII.

1. Specimen (*a*) of *M. effusa*, × ½, from above, with thin stems; cf. thick-stemmed specimen, Pl. XXV.
2. The Type specimen of *M. trabeculata*, × ½, from the side.
3. „ „ *M. informis*, × ½, from the side.

PLATE XXVIII.

1. The Type specimen of *M. efflorescens*, × ½, from the side.
2. „ „ *M. ellisi*, × ½, slightly tilted.
3. „ „ *M. striata*, × ⅔, from the side.

PLATE XXIX.

Specimen (*a*) of *M. solanderi*, × ½, from above.

PLATE XXX.

Specimen (*f*) of *M. foliosa*, × ½, from above.

PLATES XXXI.–XXXIV.

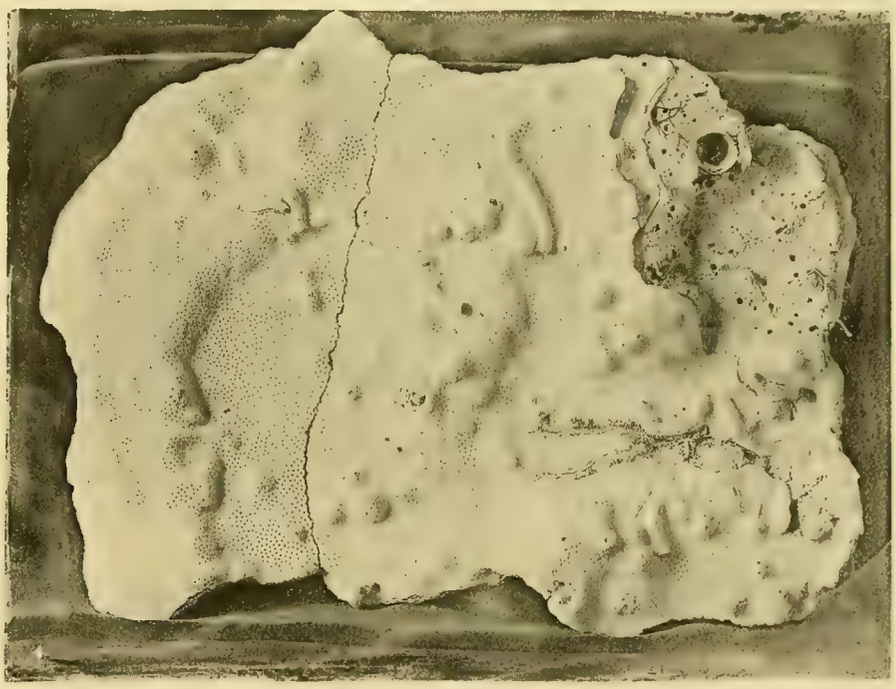
Lithographed drawings of enlarged calicles, showing details to assist in the diagnosis of the species.

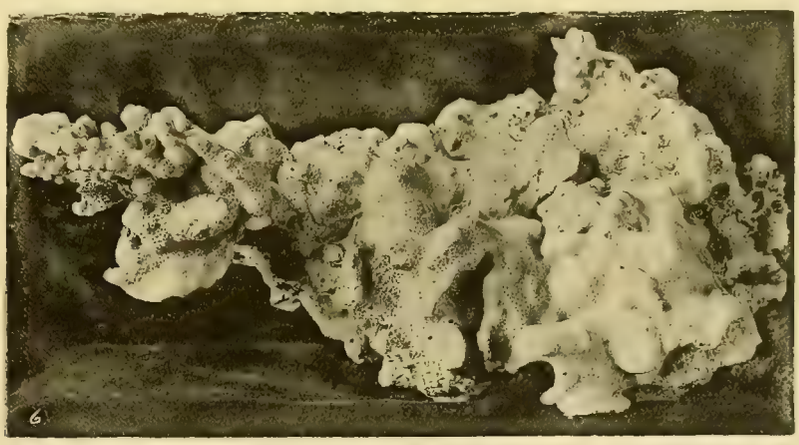
(On Pl. XXXII., fig. 9 should be *M. rubra*; see text, p. 46. On Pl. XXXIV. fig. 1, the interstitial floor shown is developed where the corallum is beginning to die down).

LONDON: PRINTED BY WILLIAM CLOWES AND SONS, LIMITED, STAMFORD STREET AND CHARING CROSS.

1. MONTIPORA STRATIFORMIS × $\frac{2}{3}$
2. MONTIPORA GRANULOSA × $\frac{2}{3}$
3. MONTIPORA EXPLANATA × $\frac{2}{3}$
4. MONTIPORA POROSA × $\frac{2}{3}$
5. MONTIPORA TENUISSIMA × $\frac{4}{5}$
6. MONTIPORA RETICULATA × $\frac{2}{3}$

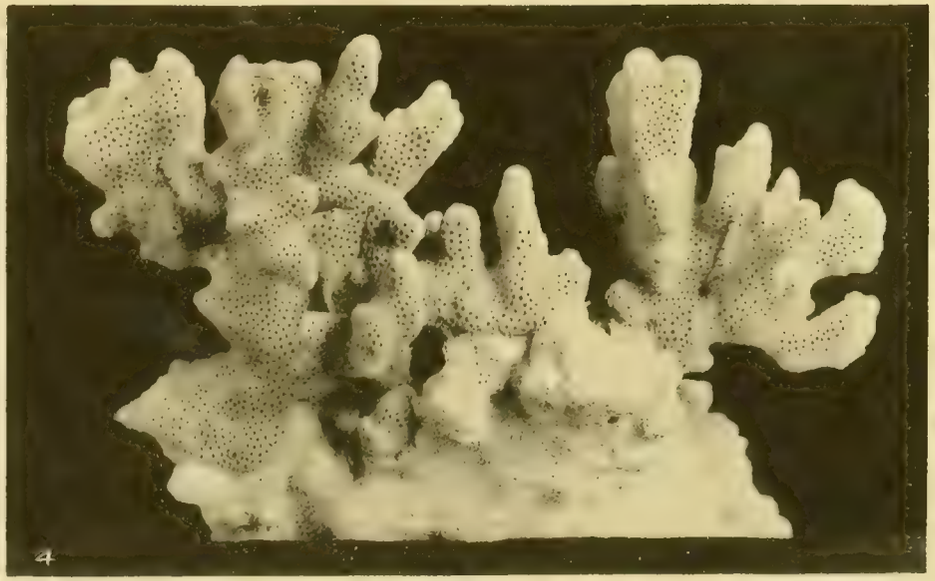
Collo: Morgan & Kidd, Richmond, S.W.



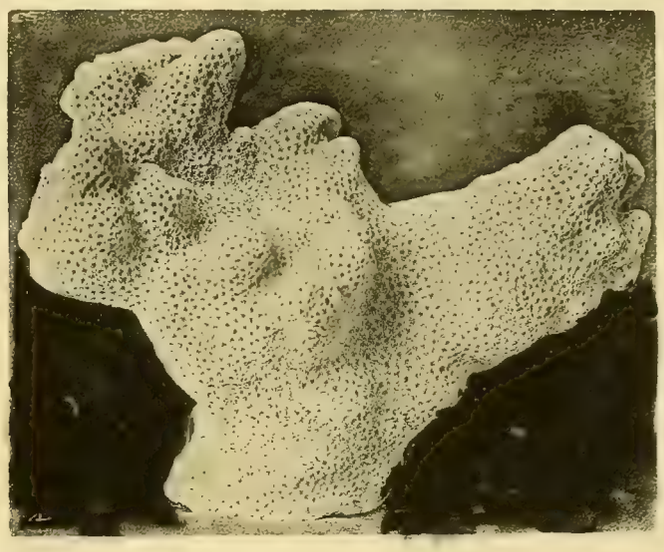


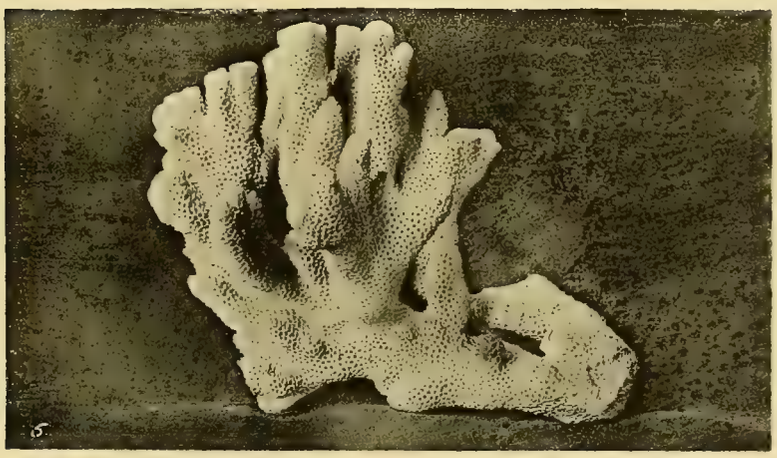
1. MONTIPORA AURICULARIS x $\frac{2}{3}$
2. MONTIPORA PALLIDA x $\frac{2}{3}$
3. MONTIPORA PUNCTATA x $\frac{2}{3}$
4. MONTIPORA EXSERTA x $\frac{1}{2}$
5. MONTIPORA CRASSI-RETICULATA x $\frac{2}{3}$
6. MONTIPORA BOLSII x $\frac{1}{3}$

Collo: Morgan & Kidd, Richmond, S.W.



1. MONTIPORA MOLLIS × $\frac{1}{2}$ 2, 3 MONTIPORA SPONGODES × $\frac{1}{2}$ 4. MONTIPORA DIVARICATA × $\frac{2}{3}$
5. MONTIPORA COMPRESSA × $\frac{5}{8}$

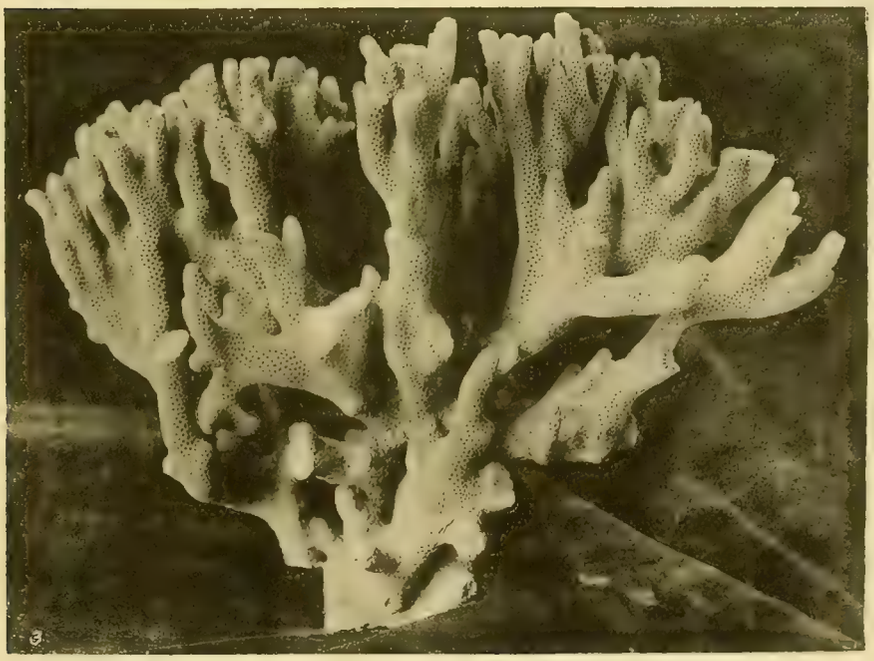




1. MONTIPORA SOLIDA.
2. MONTIPORA FRUTICOSA.
3. MONTIPORA SPATULA.
4. MONTIPORA ROTUNDA.

5 & 6. MONTIPORA GAIMARDI.

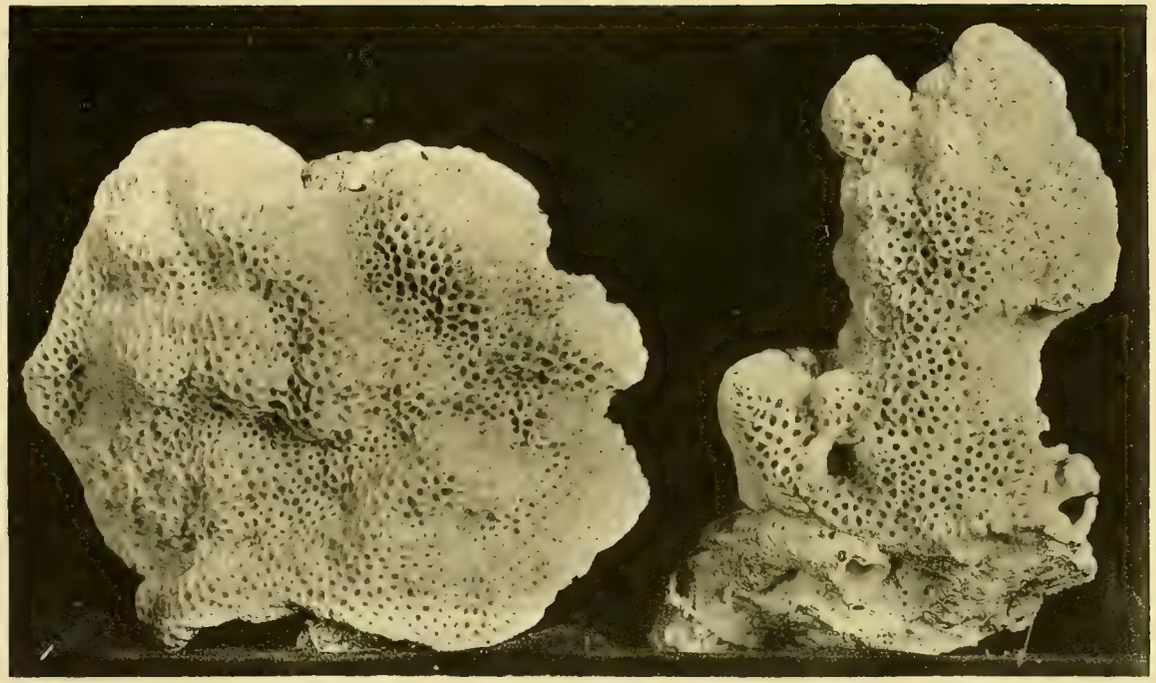
Collo : Morgan & Kidd, Richmond, S.W.

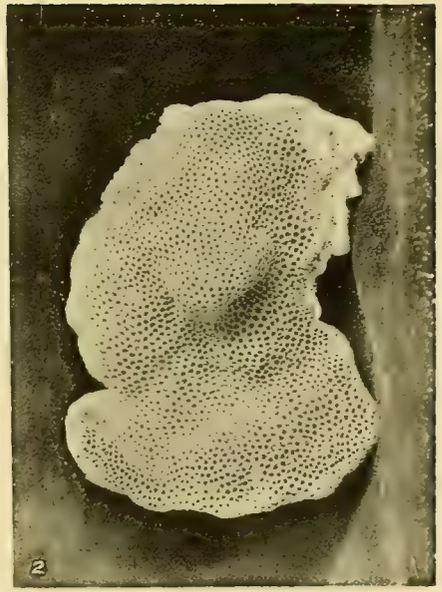


1 2 & 3. MONTIPORA RAMOSA × $\frac{1}{2}$

4. MONTIPORA SOCIALIS × $\frac{2}{3}$. 5. MONTIPORA INDENTATA × $\frac{2}{3}$.

Collo: Morgan & Kidd, Richmond, S.W.



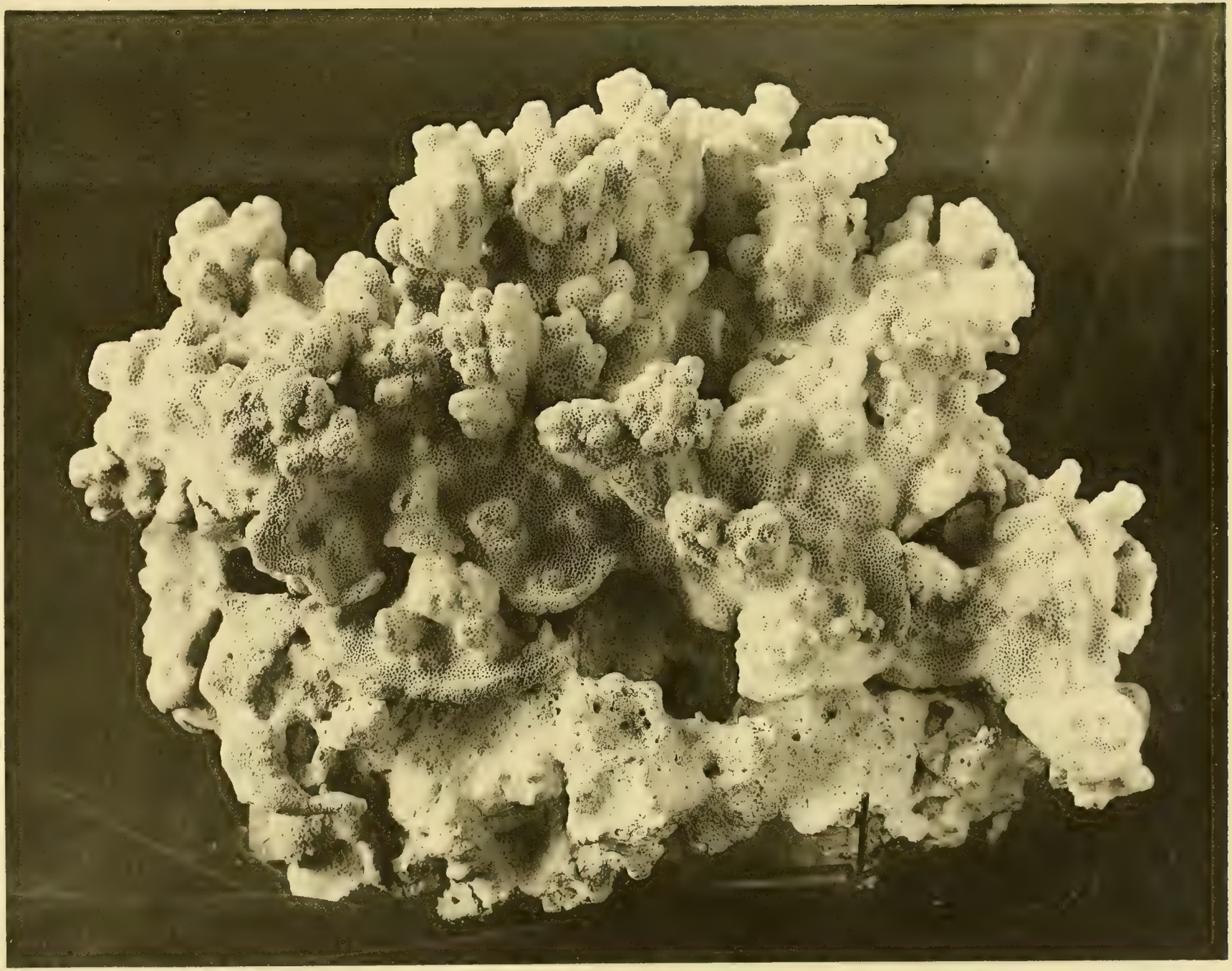


1. MONTIPORA FOVEOLATA. × $\frac{3}{4}$

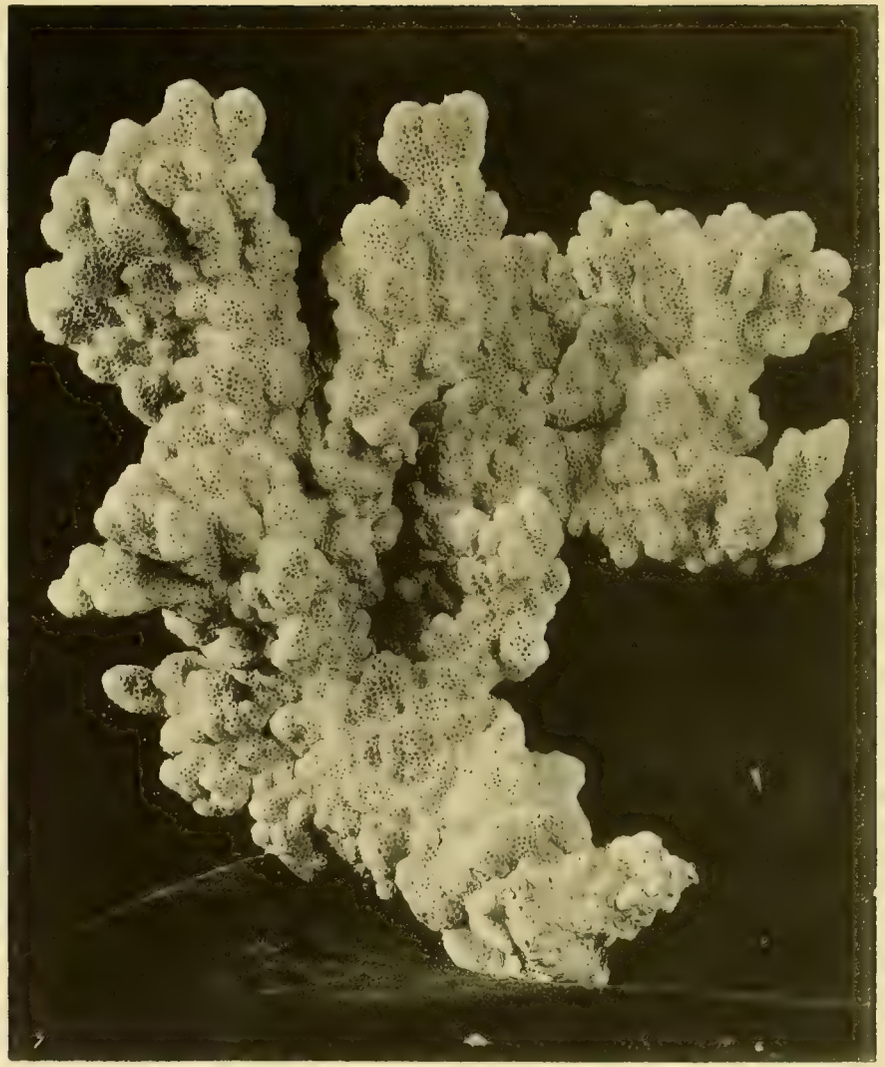
2. MONTIPORA TURGESCENS. × $\frac{2}{3}$

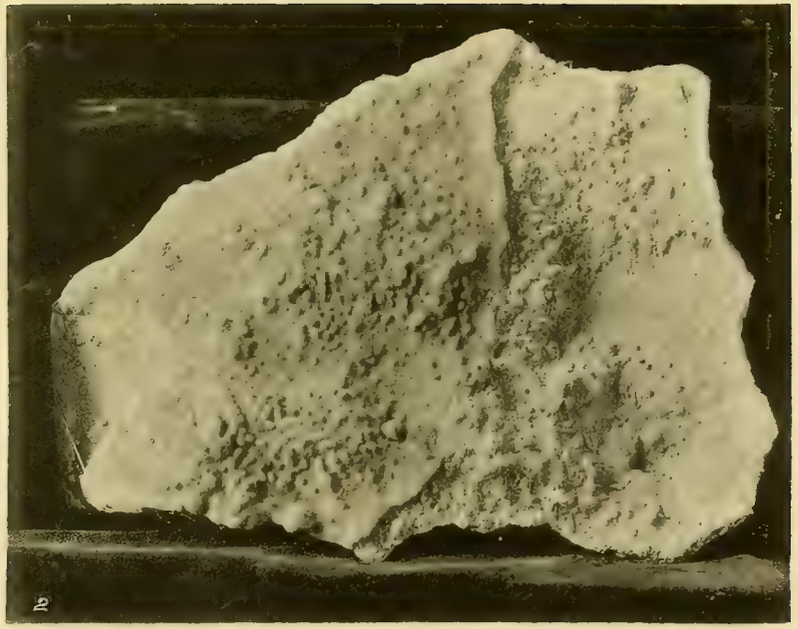
3. MONTIPORA LIBERA. × $\frac{2}{3}$

4. MONTIPORA MULTIFORMIS, (FREE STOCK). × $\frac{3}{4}$



MONTIPORA MULTIFORMIS × ⅔

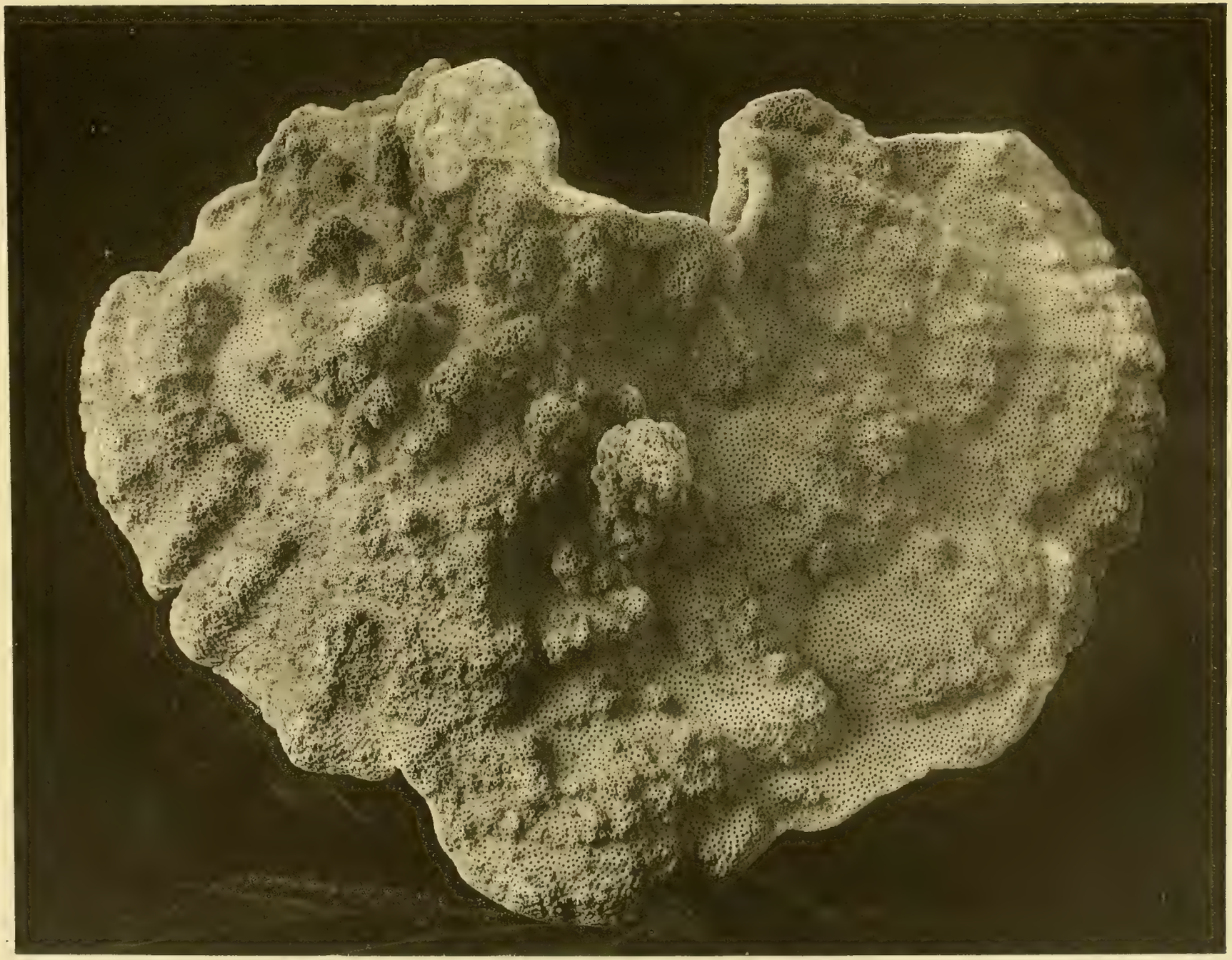




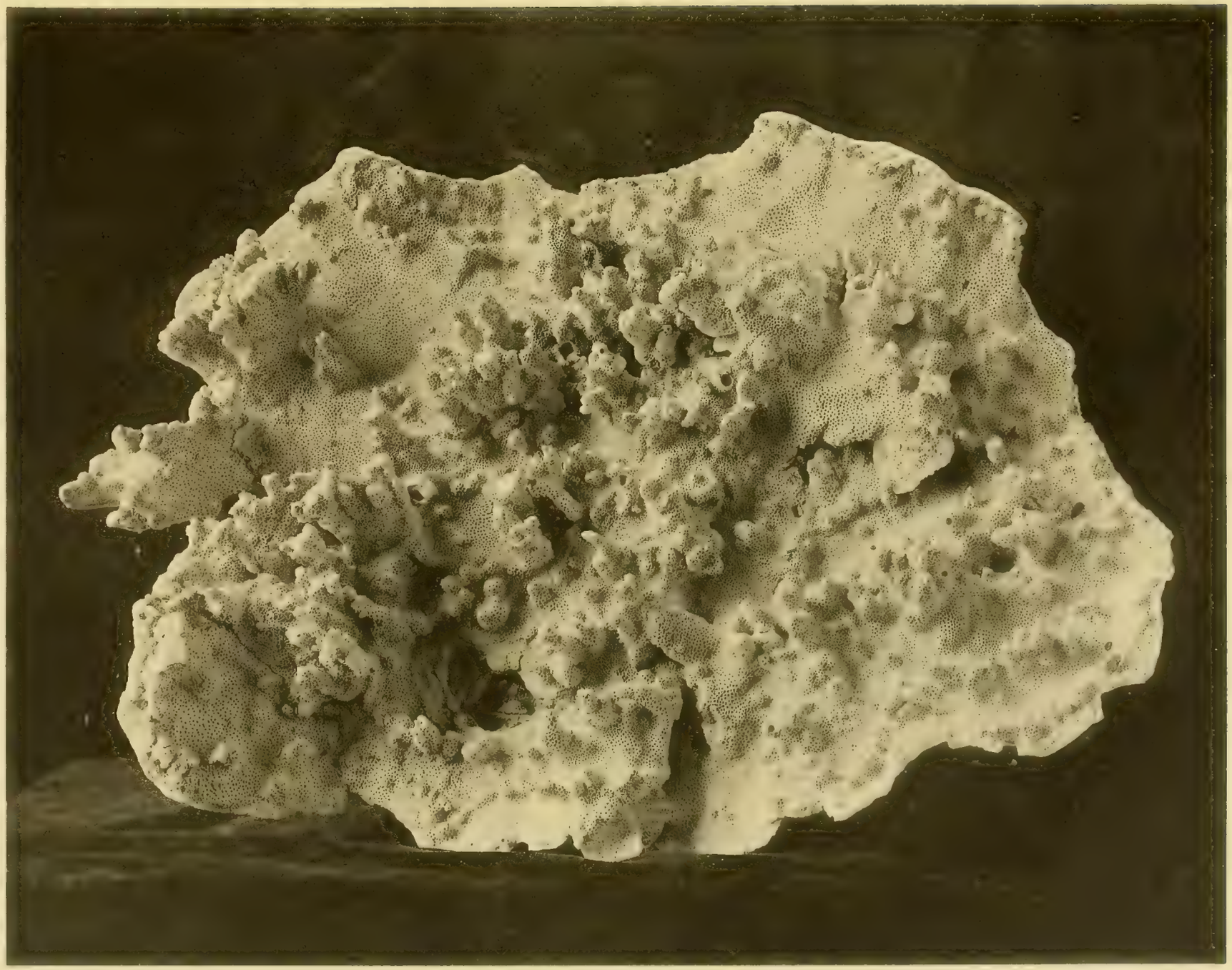
1. MONTIPORA SPUMOSA × $\frac{1}{2}$

2. MONTIPORA ÆNIGMATICA × $\frac{2}{5}$.

3. MONTIPORA EDWARDSI × $\frac{1}{2}$



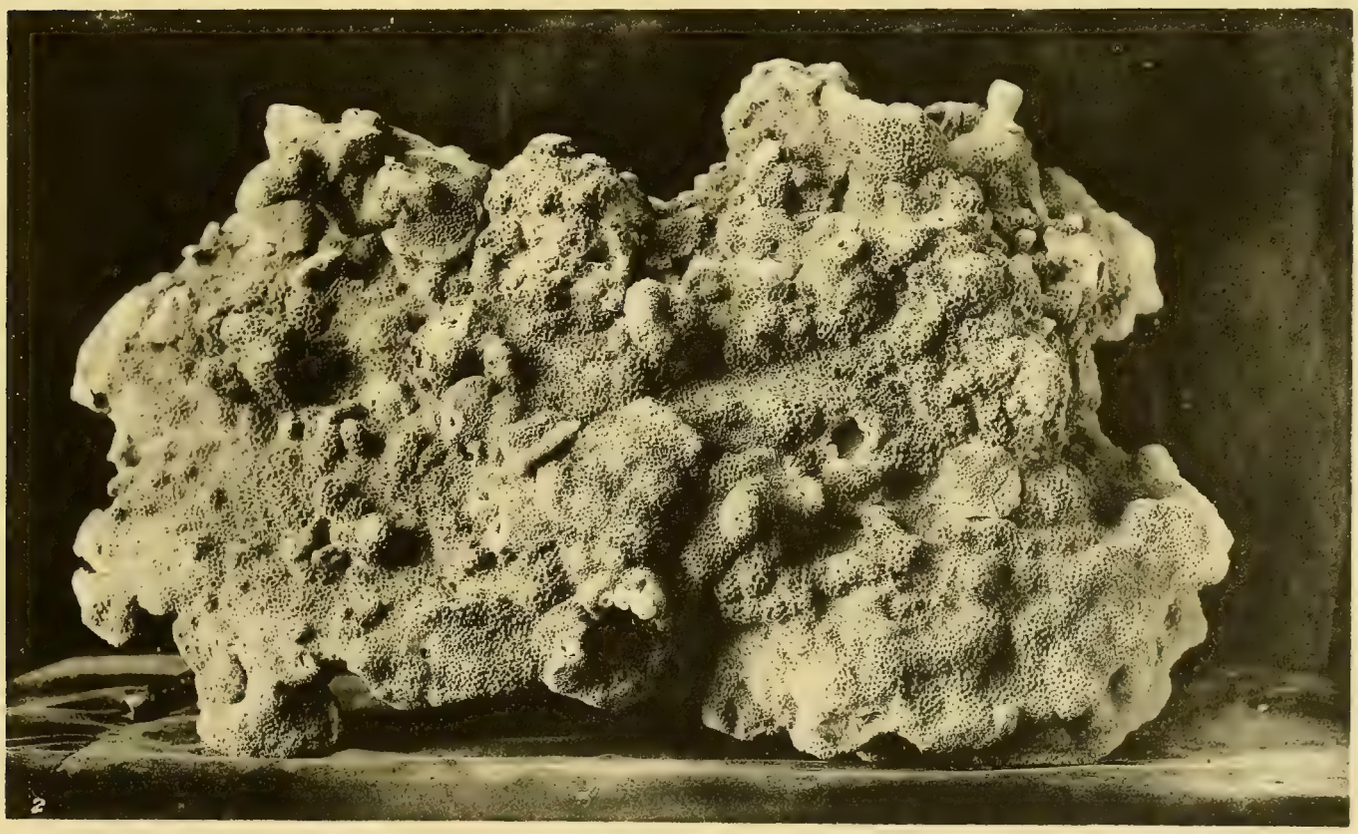
MONTIPORA CALICULATA × ½



MONTIPORA CALCAREA × $\frac{1}{2}$

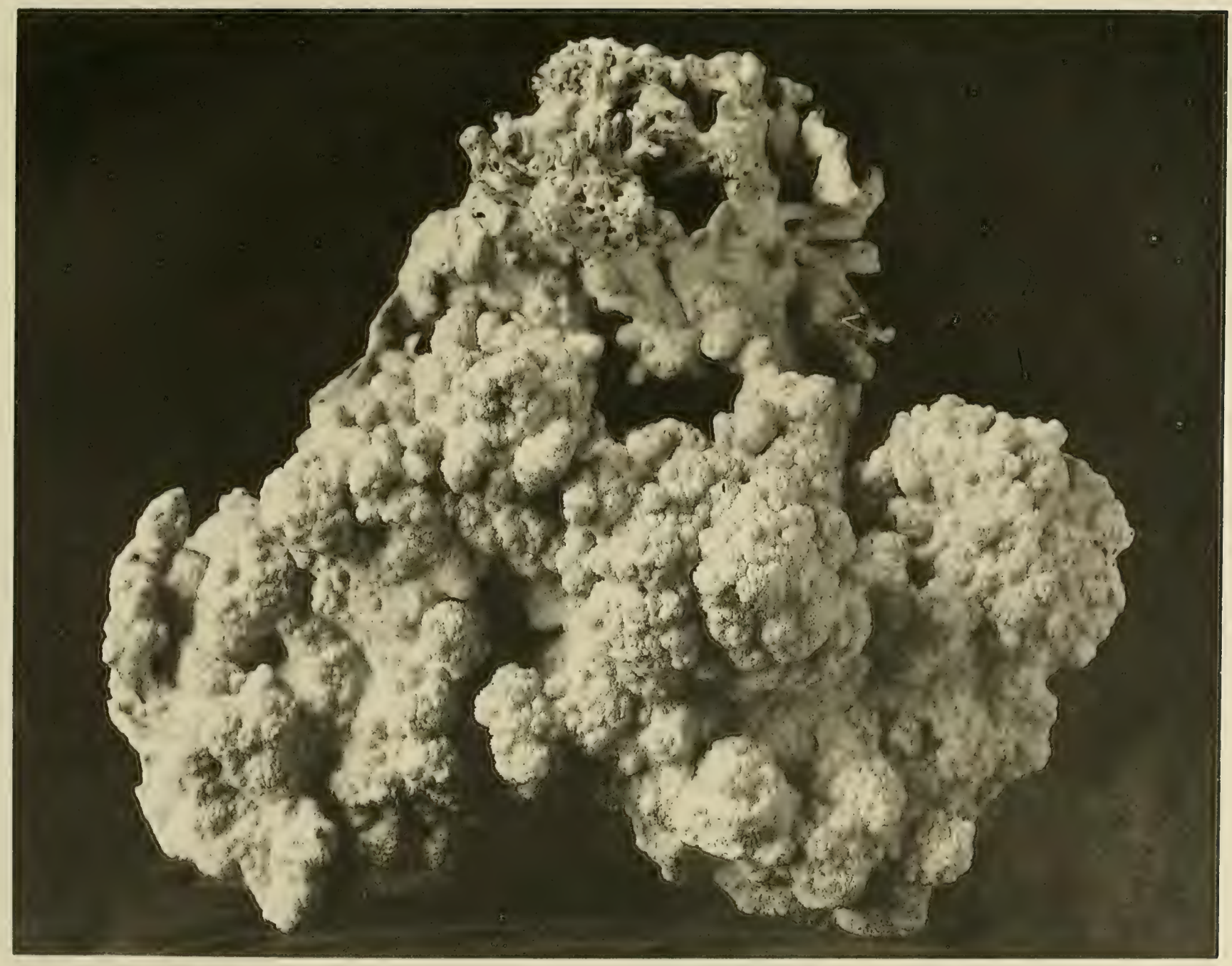
MONTIPORA SPUMOSA × $\frac{1}{3}$

Collotype Morgan & Kidd, Richmond, S.W.



1. MONTIPORA ACANTHELLA × $\frac{1}{2}$. 2. MONTIPORA FUNGIFORMIS × $\frac{1}{2}$.

Collo : Morgan & Kidd, Richmond, S.W.

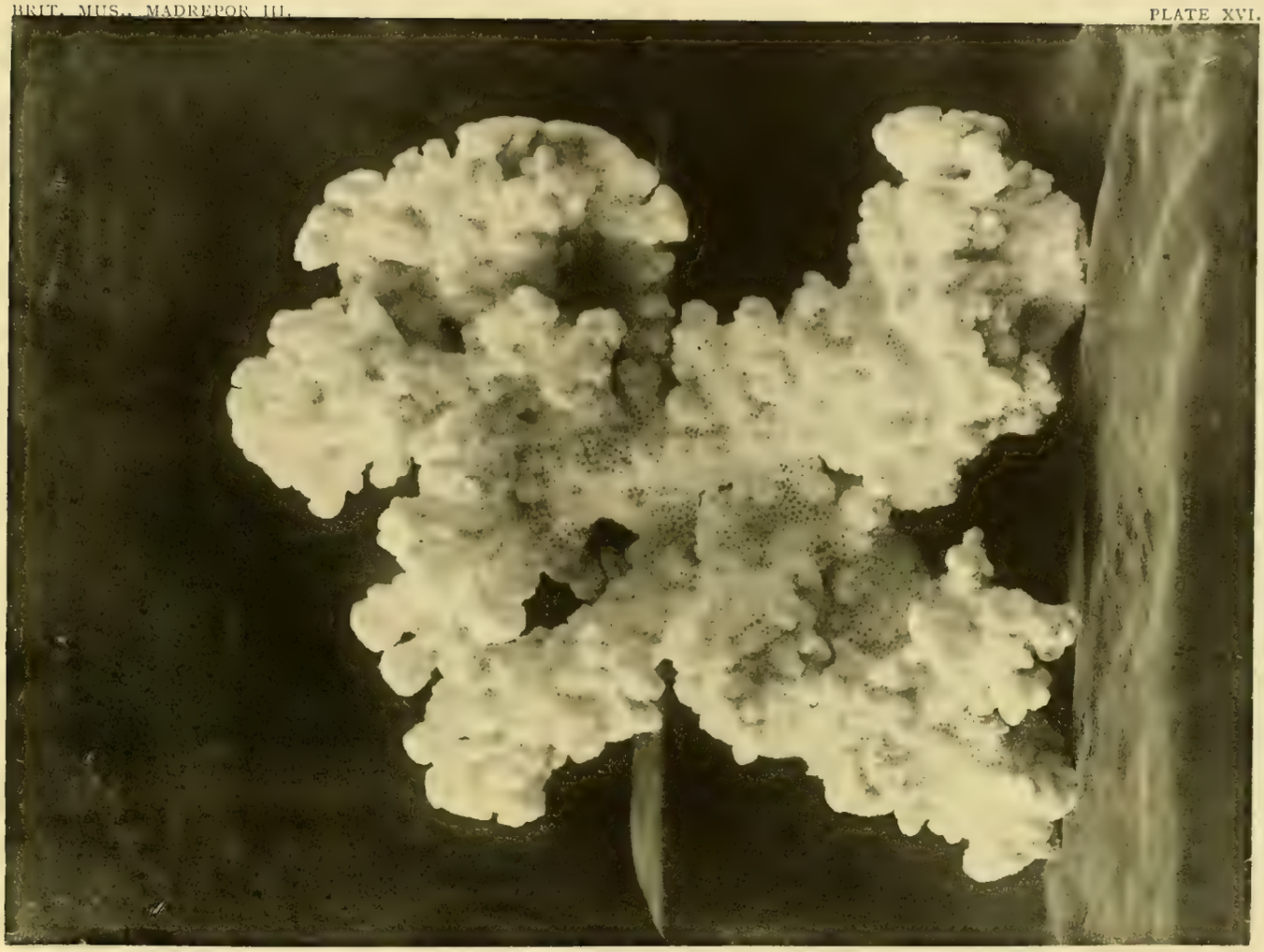


MONTIPORA LANUGINOSA × $\frac{1}{2}$

MONTIPORA LOBULATA × $\frac{2}{3}$

MONTIPORA GUPPYI × ⅔

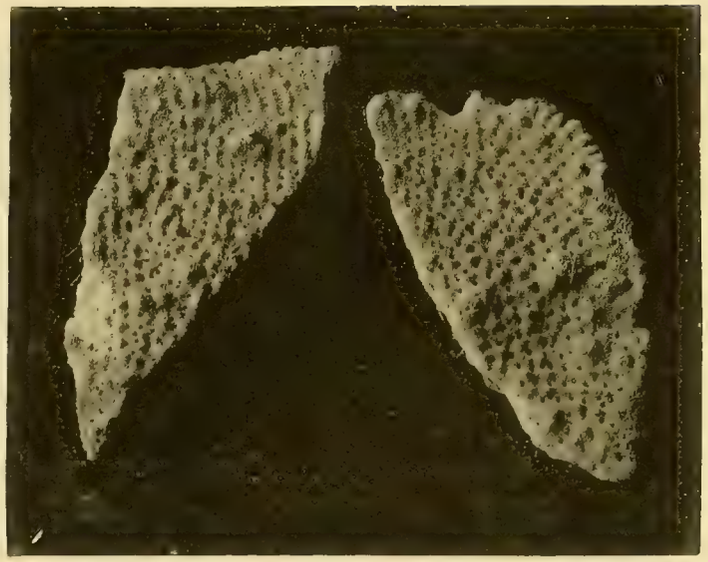
Collotype Morgan & Kidd, Richmond, S.W.

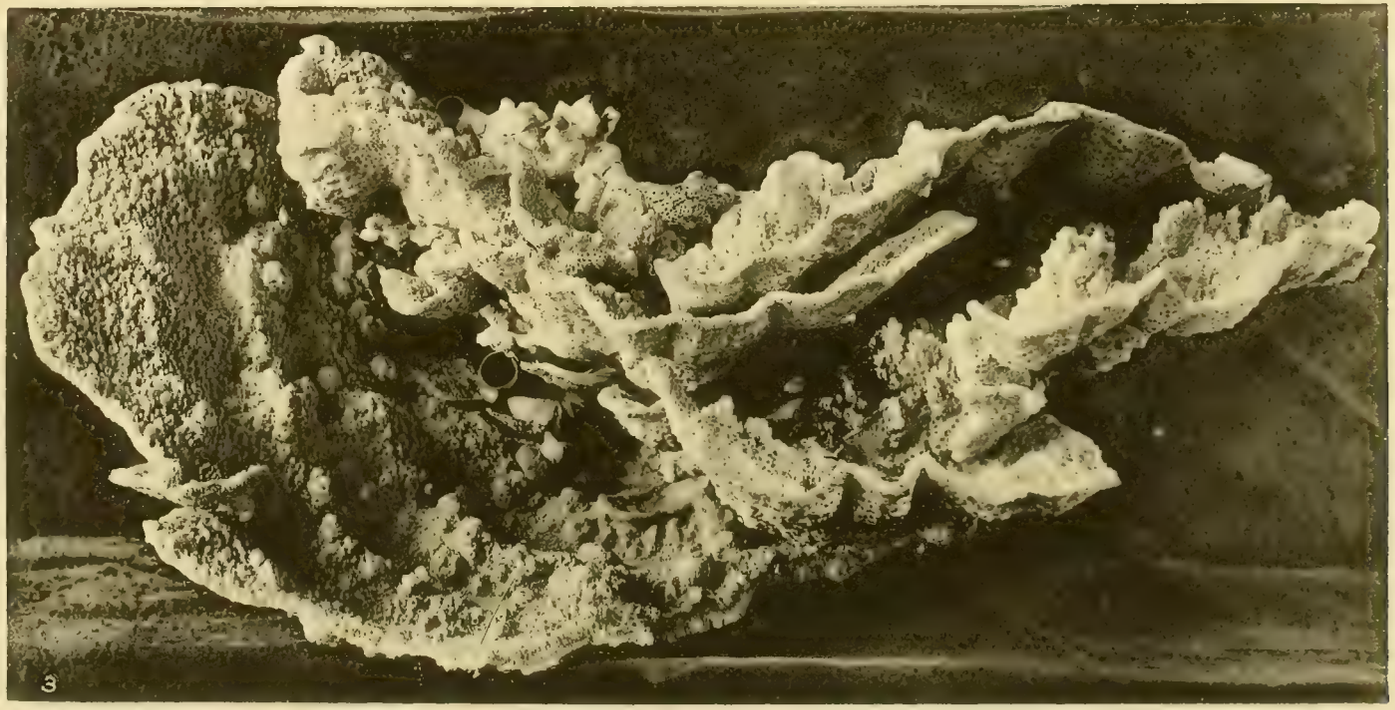


1. MONTIPORA LOBULATA × $\frac{2}{3}$ 2. MONTIPORA BILAMINATA × $\frac{2}{3}$

3. MONTIPORA TUBIFERA × $\frac{3}{4}$

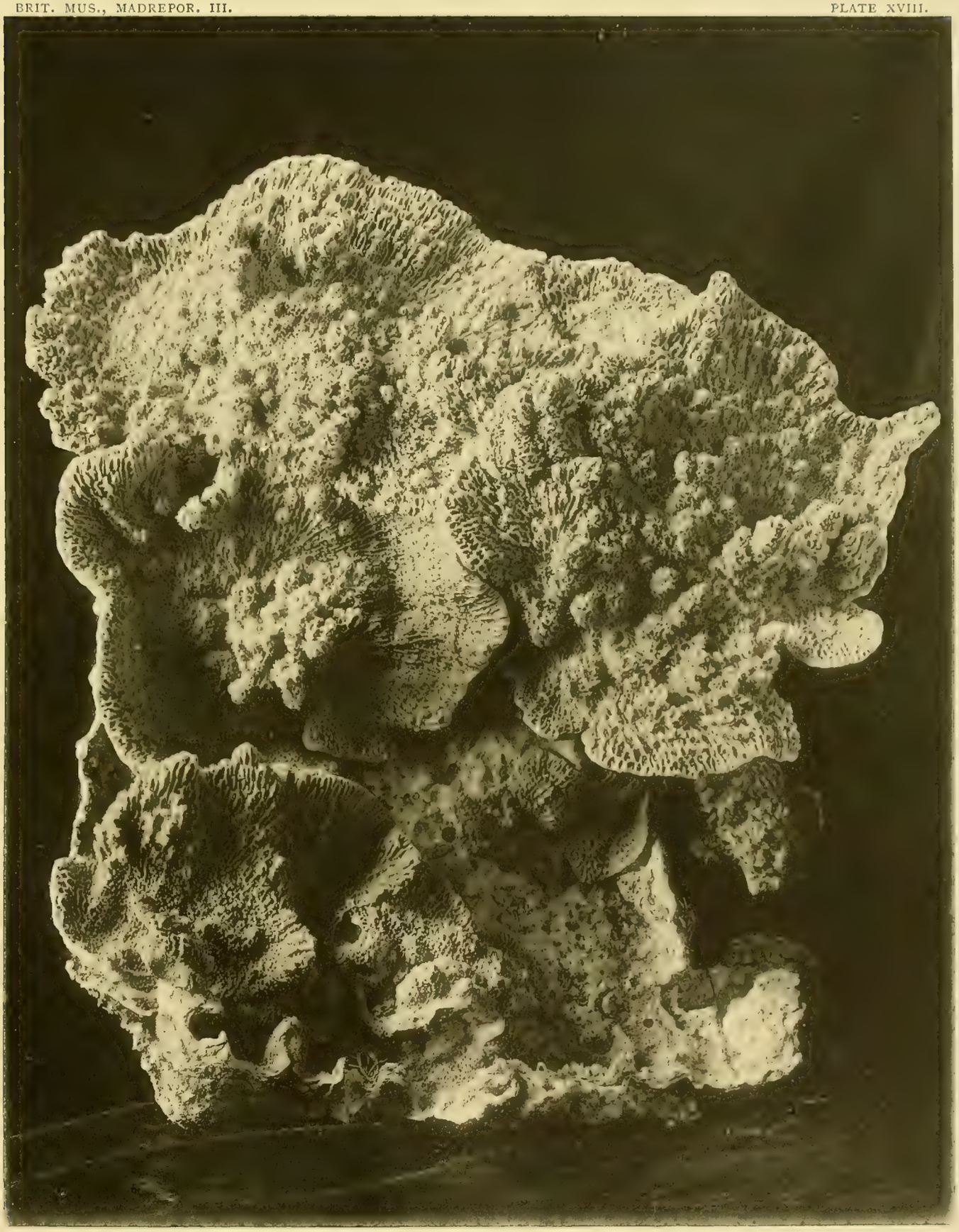
Collo : Morgan & Kidd, Richmond, S.W.





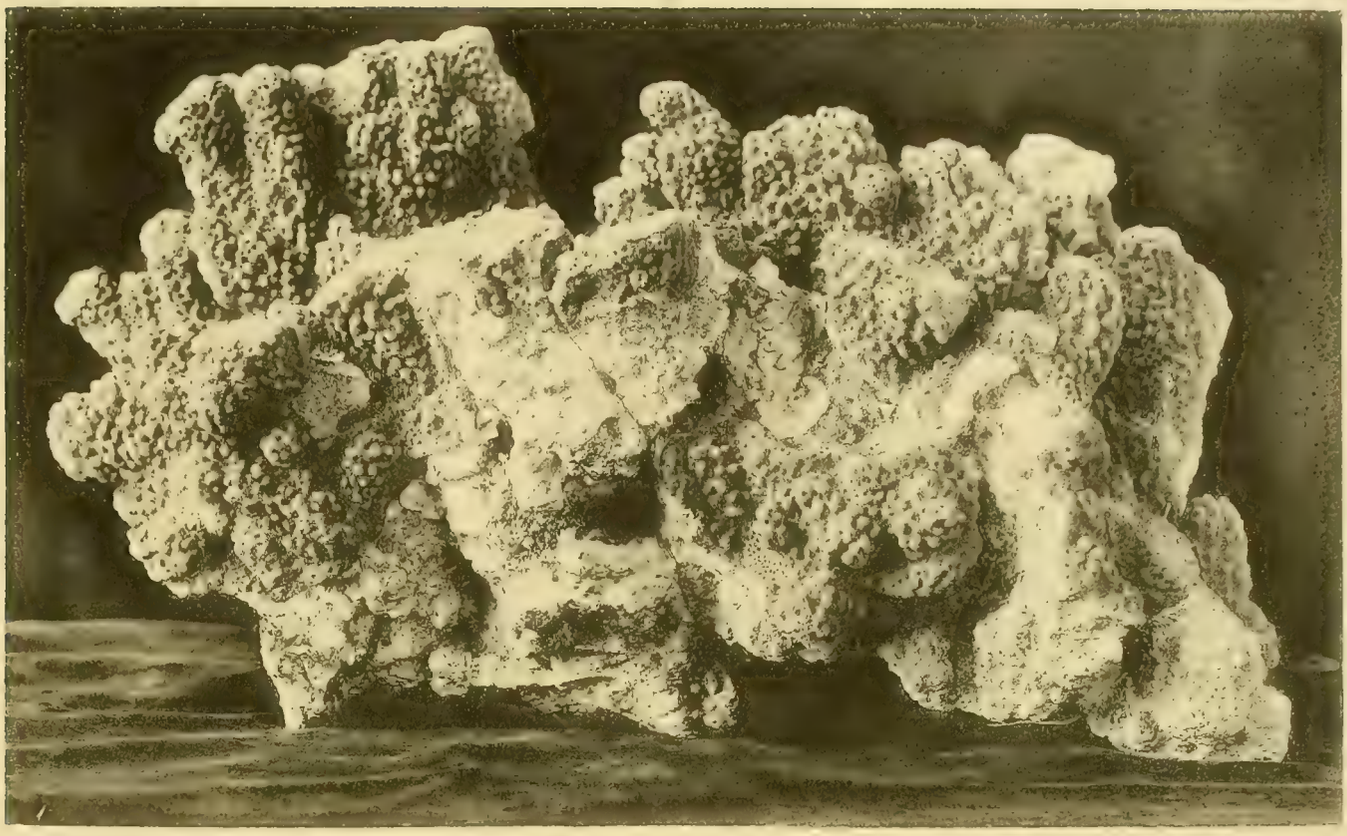
1. MONTIPORA DENTICULATA x $\frac{3}{3}$ 2. MONTIPORA PULCHERRIMA x $\frac{2}{3}$.

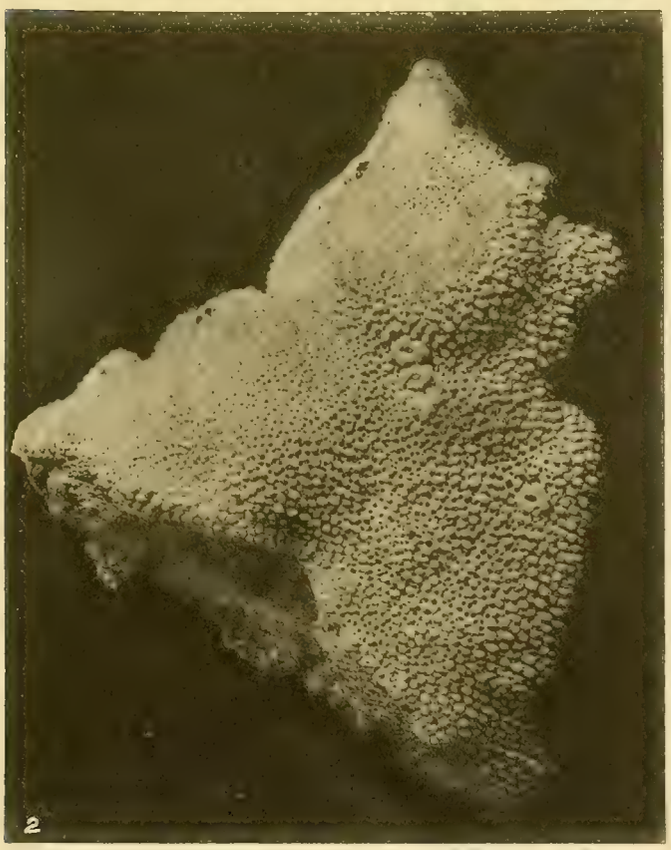
3. MONTIPORA AUSTRALIENSIS x $\frac{1}{2}$



MONTIPORA PROLIFERA × $\frac{2}{3}$

Collotype Morgan & Kidd, Richmond, S.W.



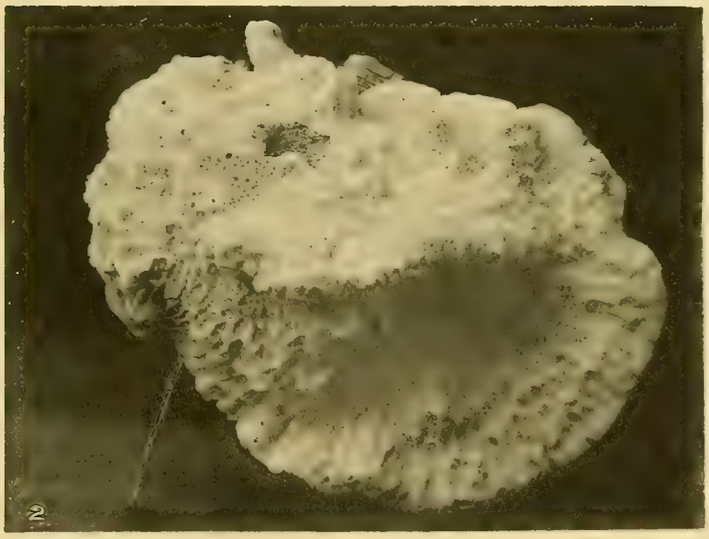


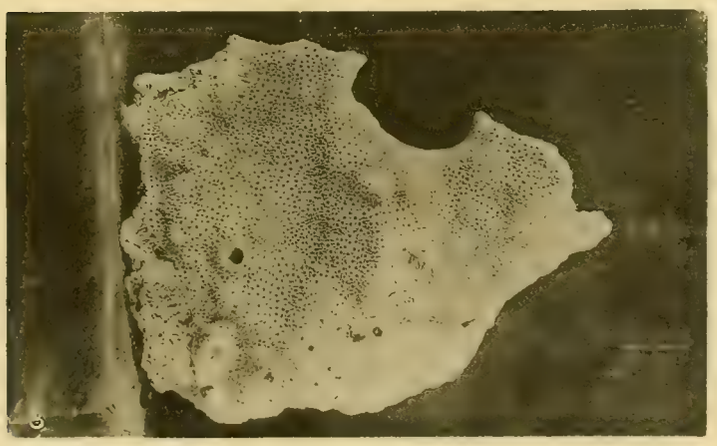
1. MONTIPORA MÆANDRINA × $\frac{3}{4}$ 2. MONTIPORA VERRUCOSA × $\frac{1}{2}$

3. MONTIPORA SINENSIS × $\frac{1}{2}$

Collo: Morgan & Kidd, Richmond, S.W.

MONTIPORA DANÆ × $\frac{2}{3}$





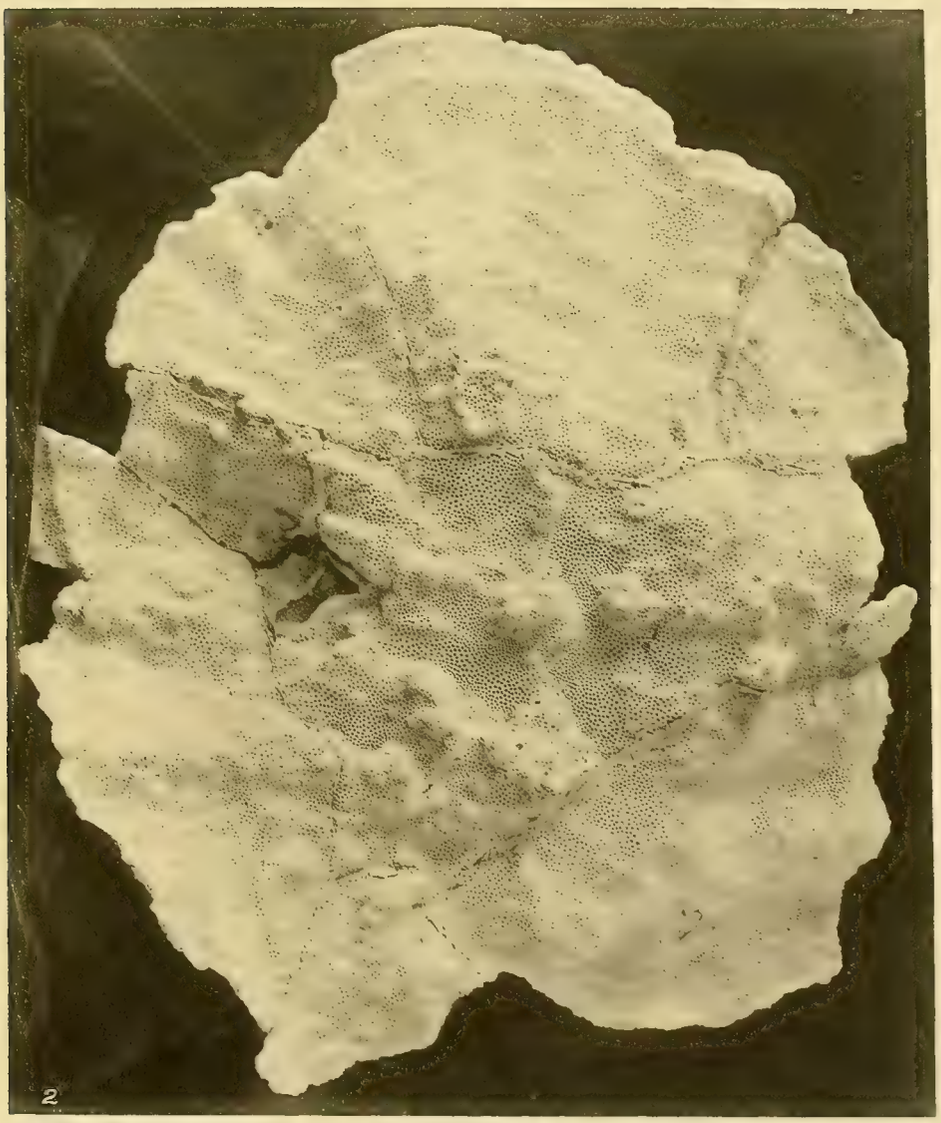
1. MONTIPORA AMBIGUA × $\frac{1}{2}$
2. MONTIPORA UNDATA × $\frac{1}{2}$
3. MONTIPORA PERFORATA × $\frac{2}{3}$
4. MONTIPORA MAMMILATA × $\frac{2}{3}$
5. MONTIPORA CACTUS × $\frac{2}{3}$

Collo: Morgan & Kidd Richmond, S.W.

1. MONTIPORA CHALLENGERI × $\frac{2}{3}$

2. MONTIPORA SCUTATA × $\frac{2}{3}$

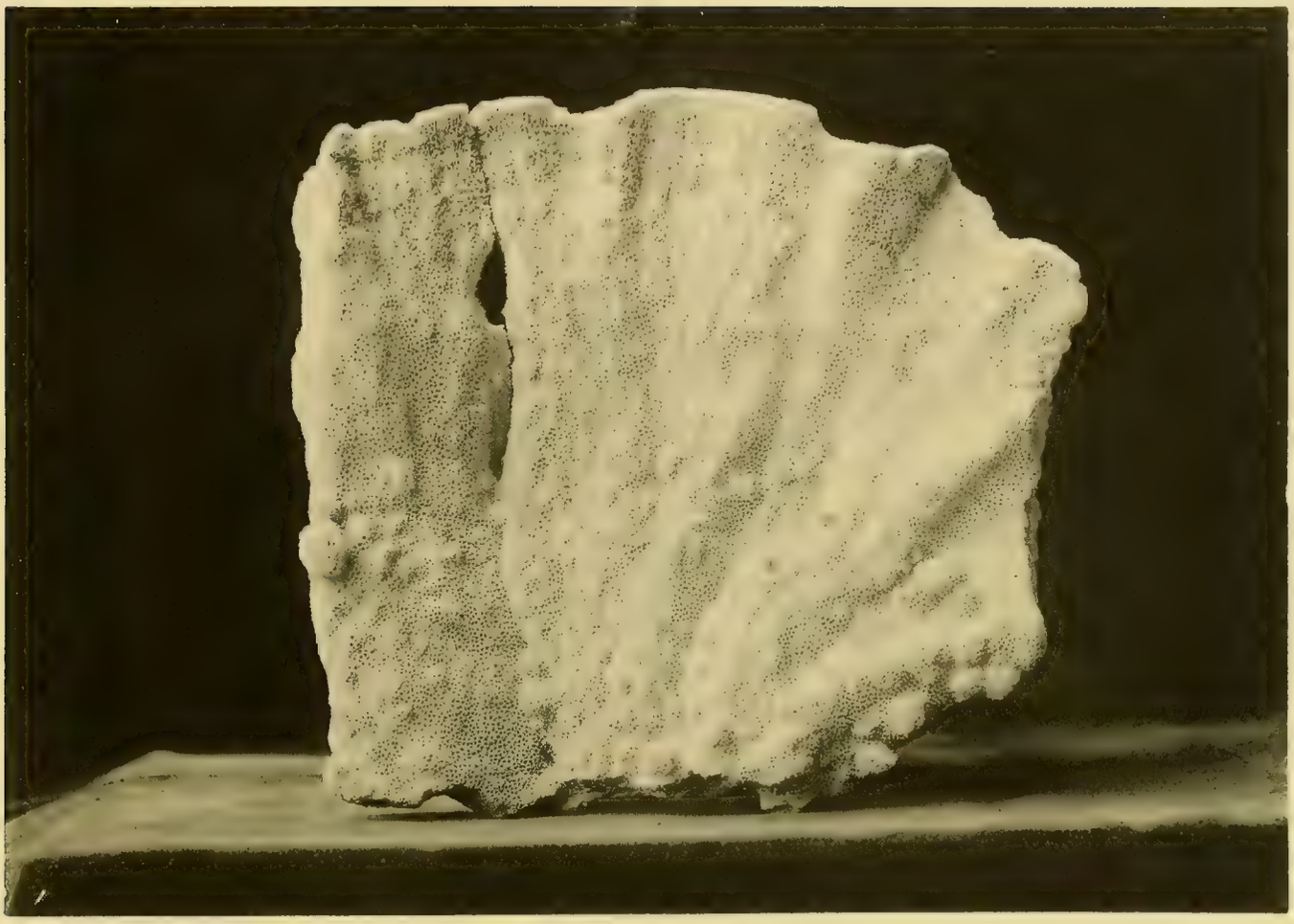
Collo: Morgan & Kidd, Richmond, S.W.

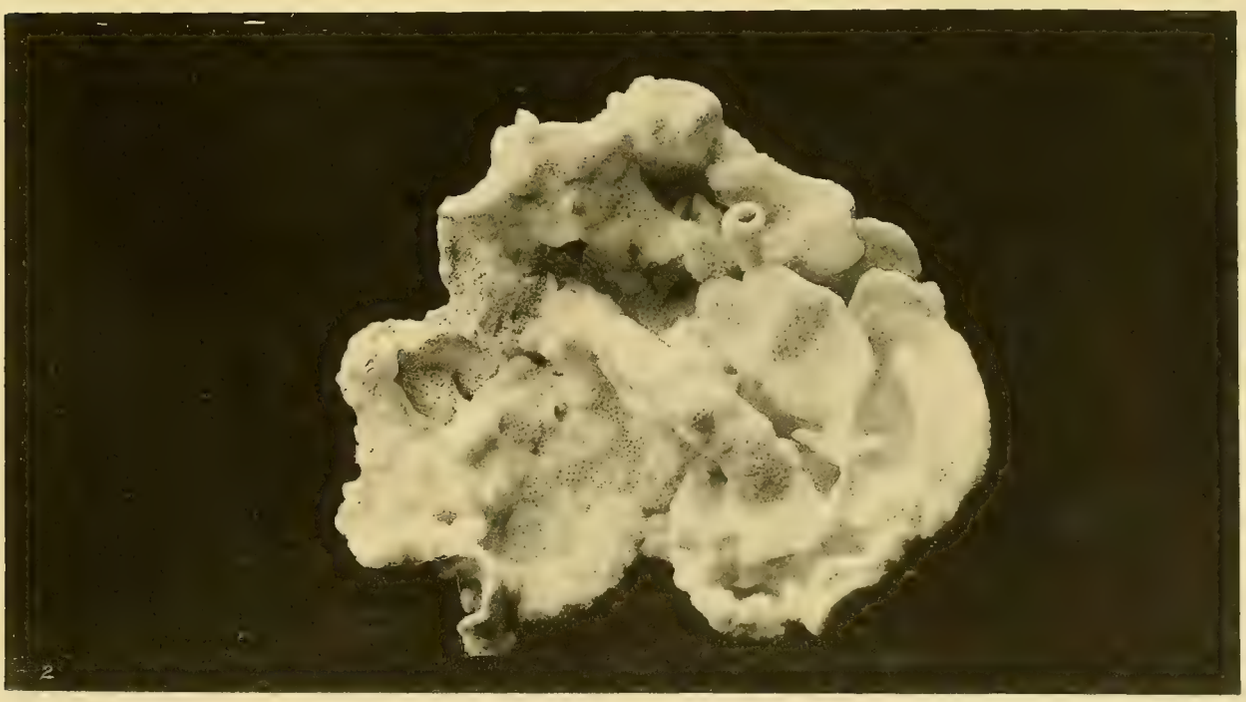


1 & 2. MONTIPORA PELTIFORMIS × ½ 3. MONTIPORA MINUTA × ¾

4. MONTIPORA ANNULARIS × ¾

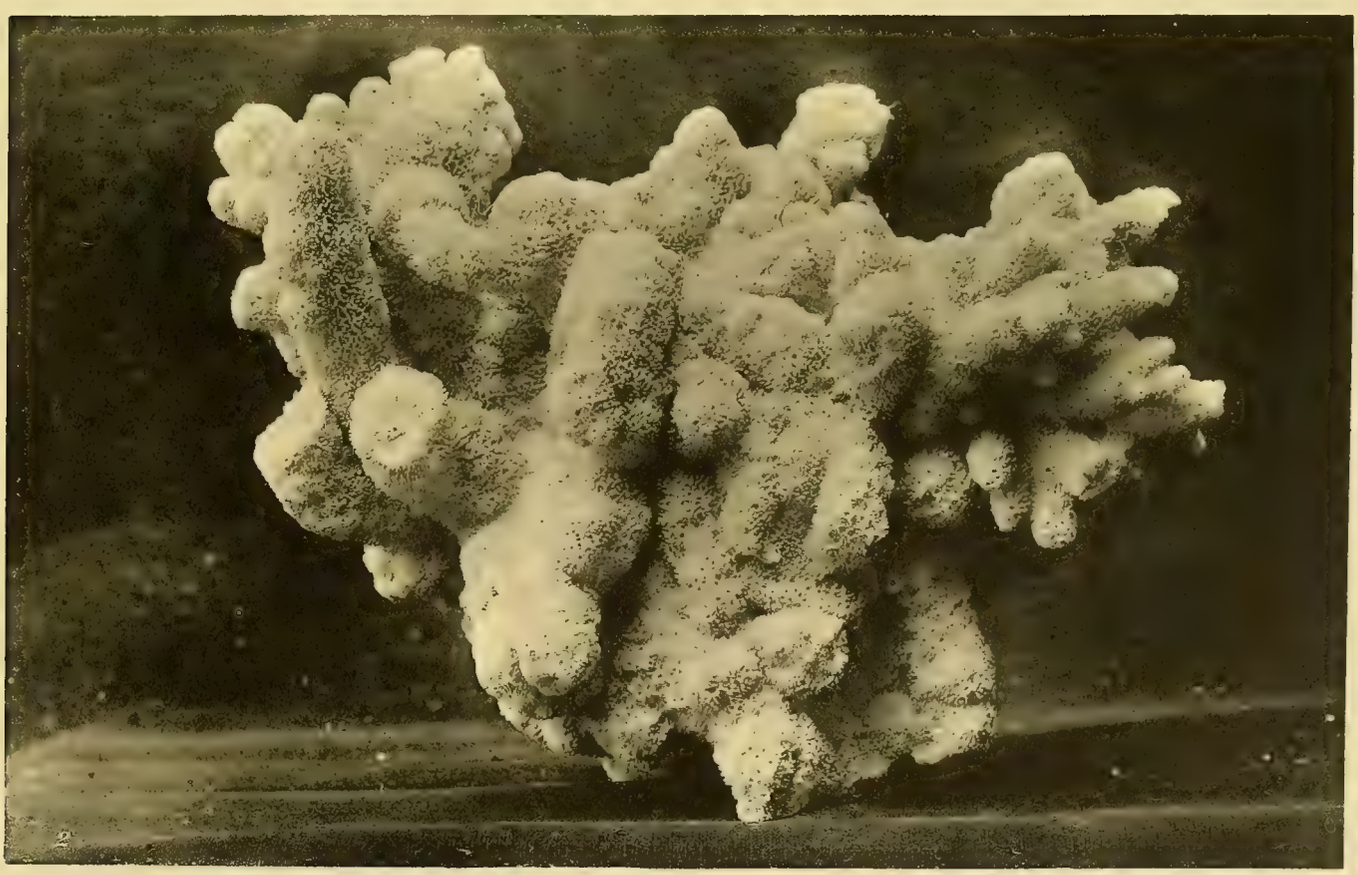
Collo : Morgan & Kidd, Richmond, S.W.





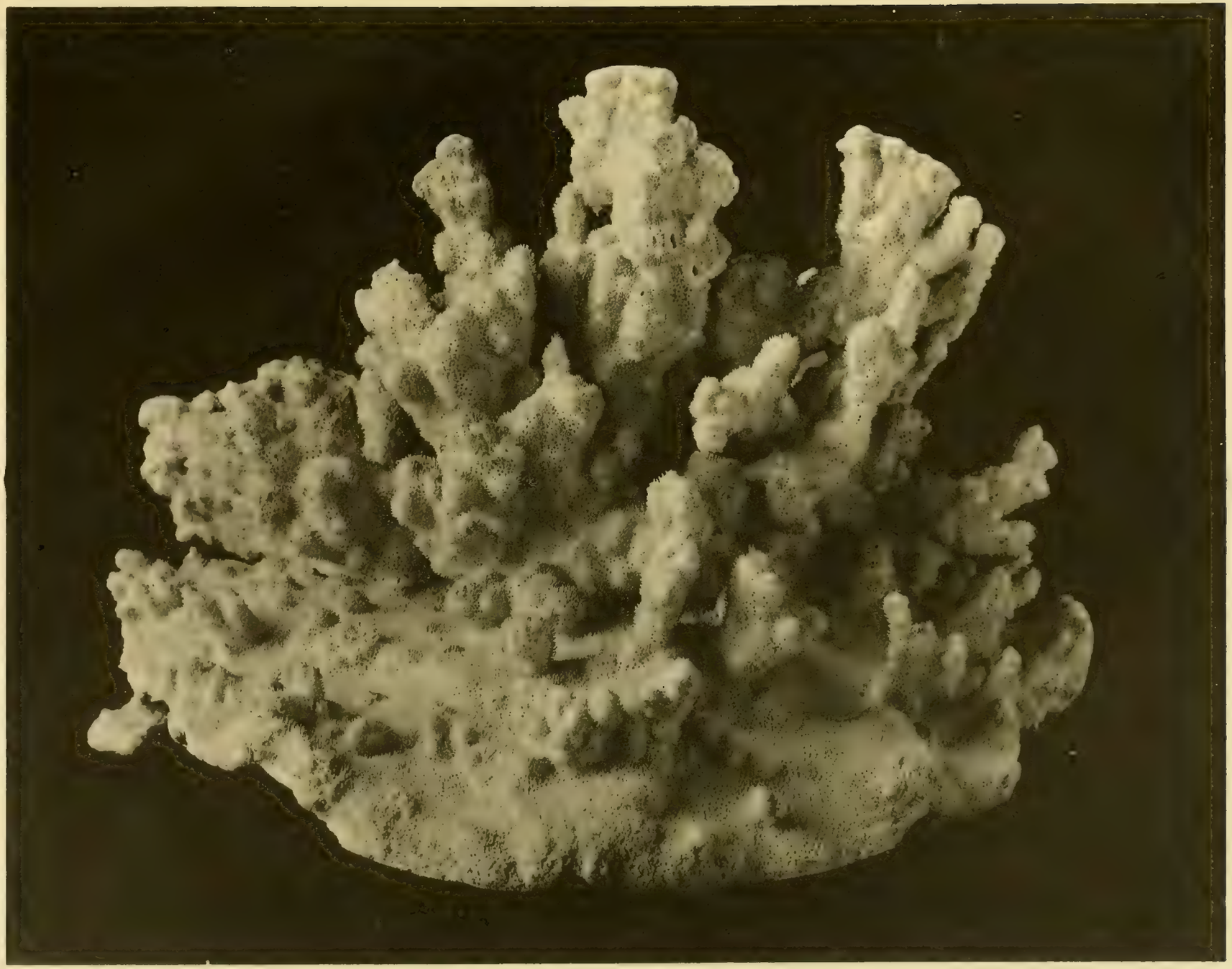
1. MONTIPORA INCOGNITA × ½ 2. MONTIPORA FRIABILIS × ½

Collo: Morgan & Kidd, Richmond, S.W.

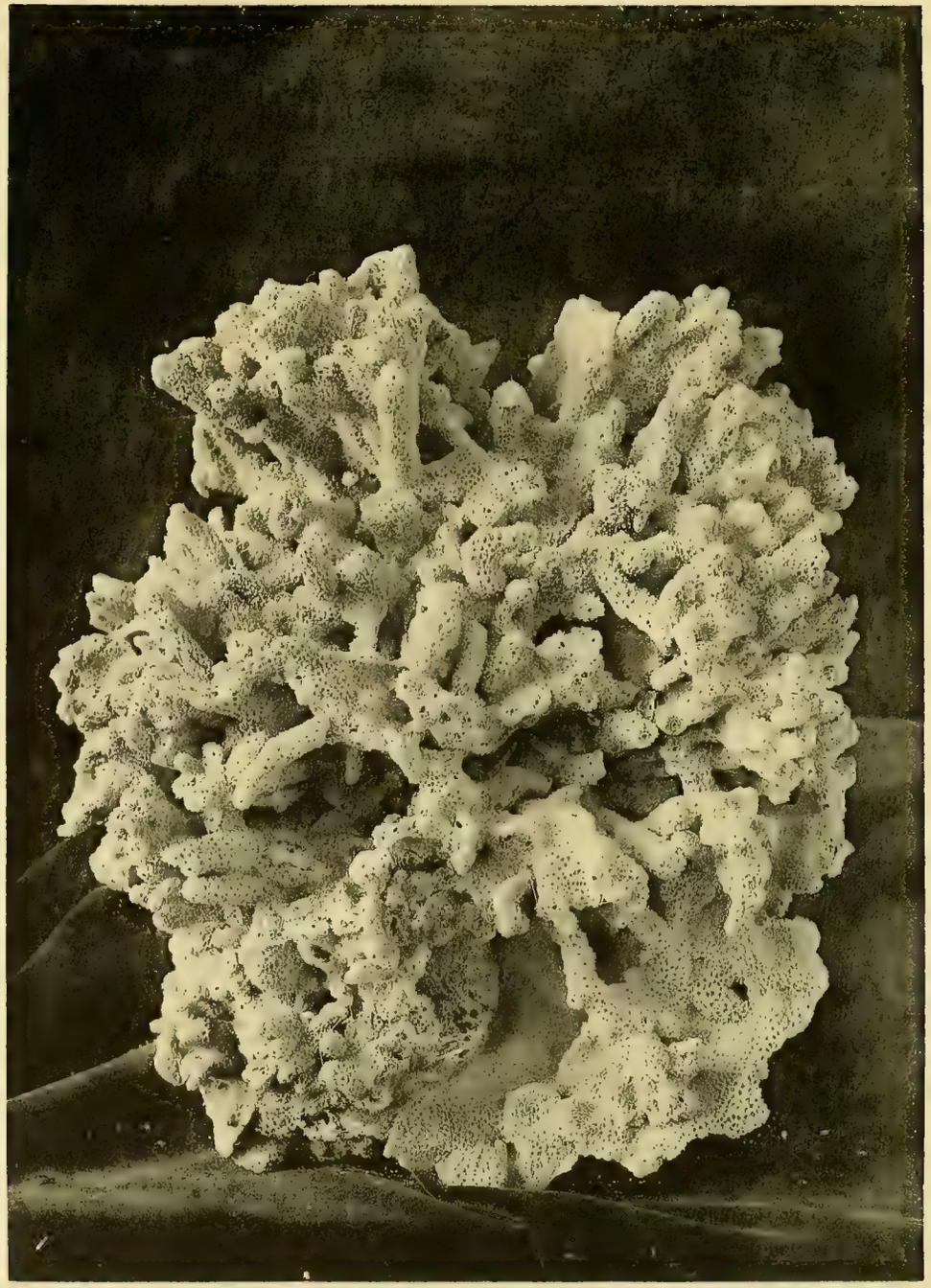


1. MONTIPORA CRASSI-TUBERCULATA × $\frac{2}{3}$ 2. MONTIPORA EFFUSA × $\frac{2}{3}$

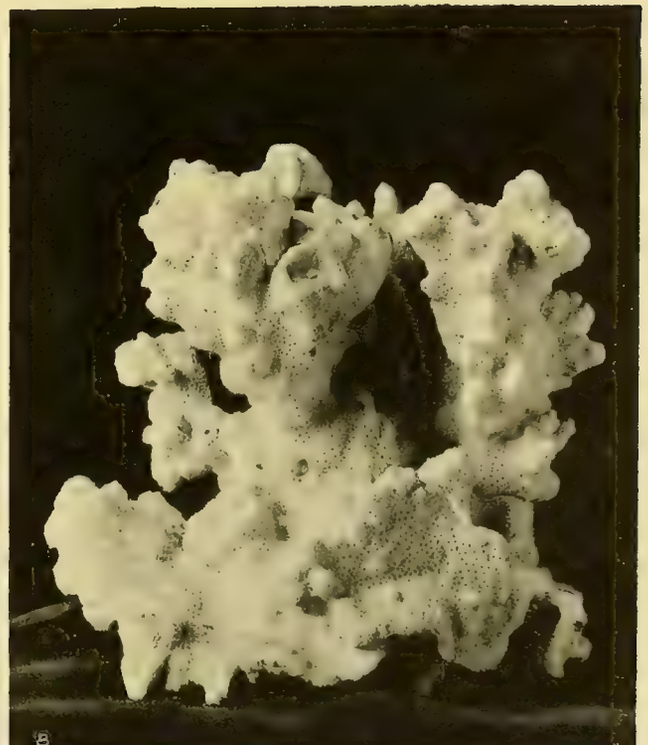
Collo : Morgan & Kidd, Richmond, S.W.



MONTIPORA HISPIDA × ⅔

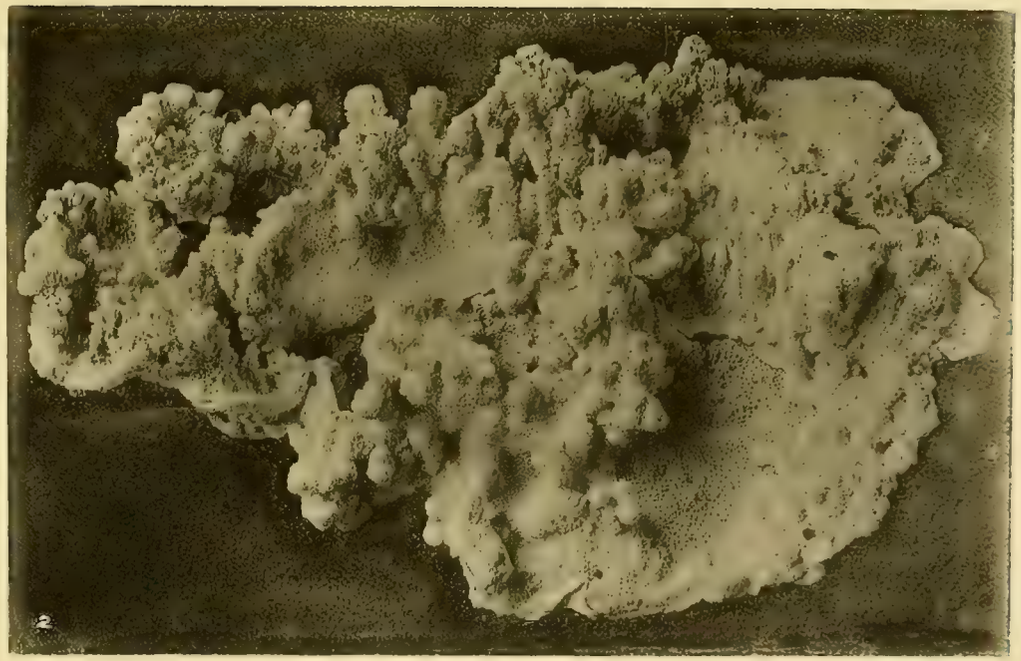


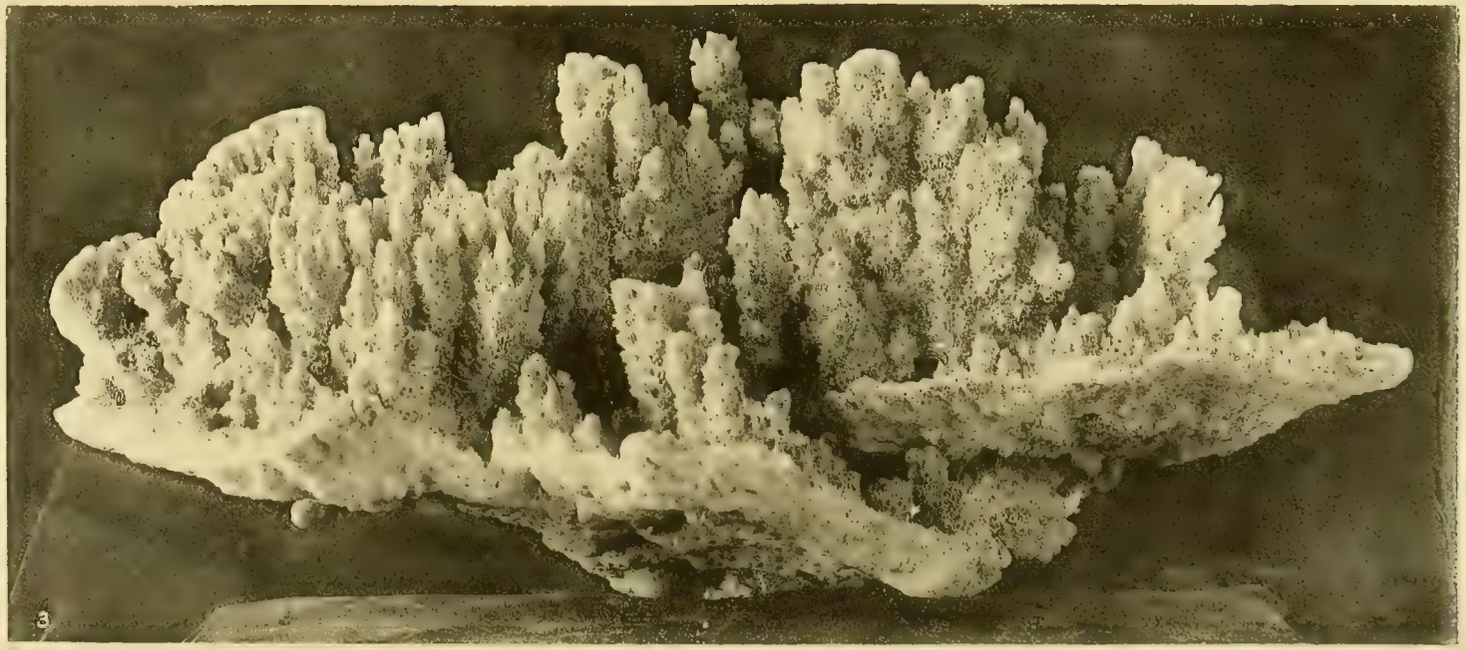
1. MONTIPORA EFFUSA × ½



2. MONTIPORA TRABECULATA × ½

3. MONTIPORA INFORMIS × ½

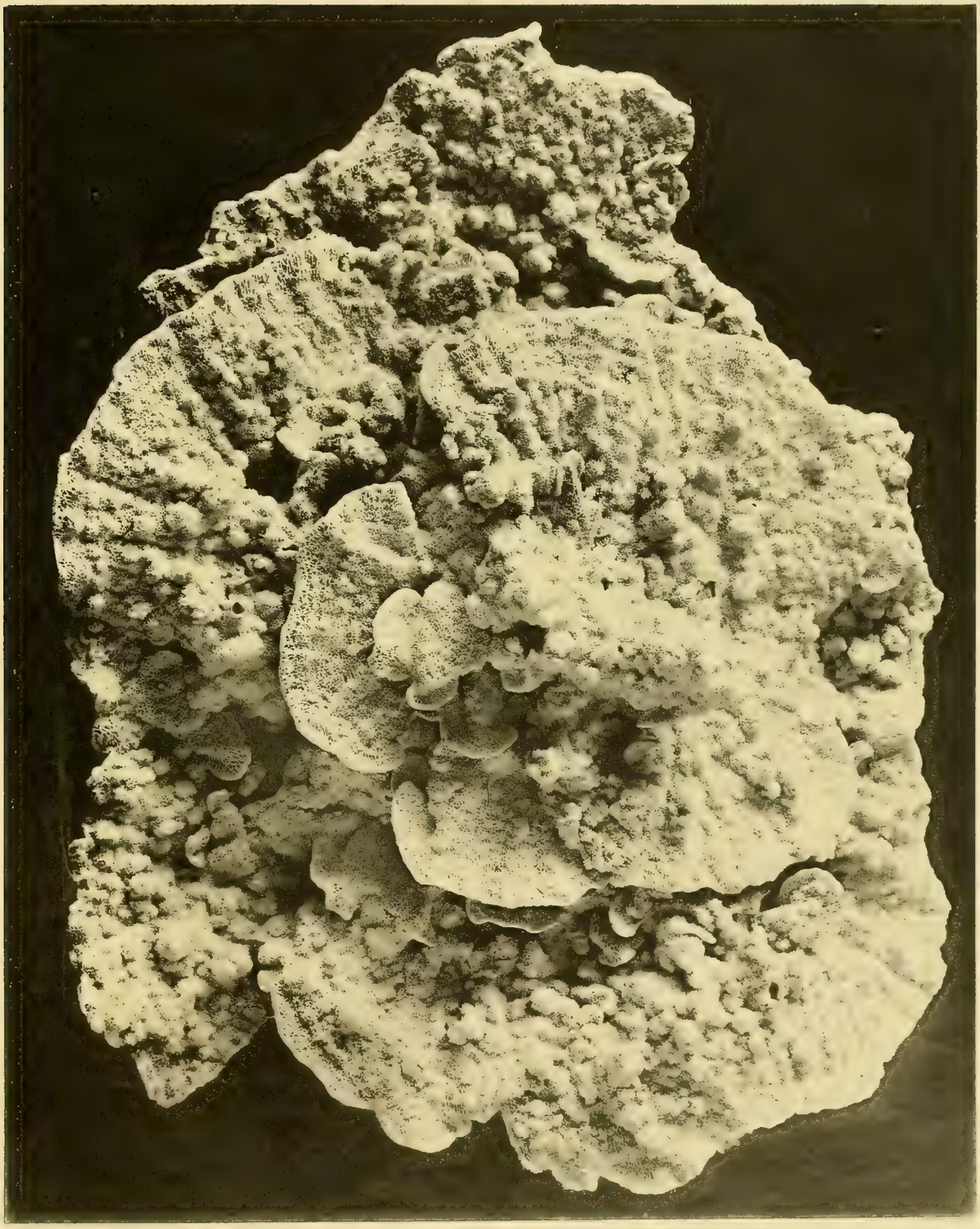




1. MONTIPORA EFFLORESCENS × ½

2. MONTIPORA ELLISI × ½

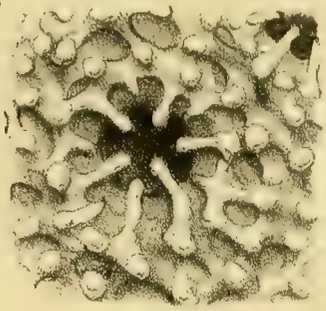
3. MONTIPORA STRIATA × ⅔



MONTIPORA SOLANDERI × ½

Collotype Morgan & Kidd, Richmond, S.W.

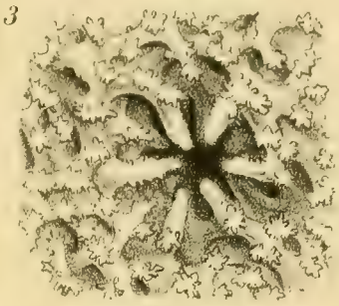
MONTIPORA FOLIOSA × $\frac{1}{2}$

1 

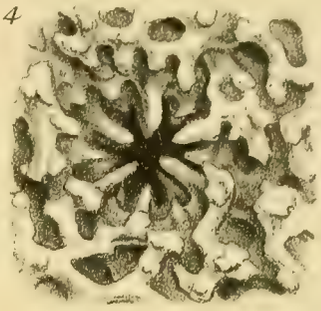
M. exigua . X 35.

2

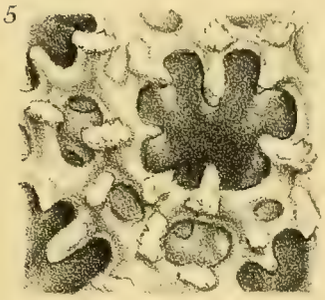
M. subtilis. X 40.

3 

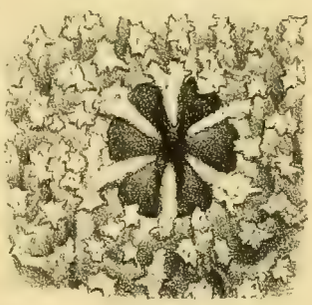
M. granulosa X 30.

4 

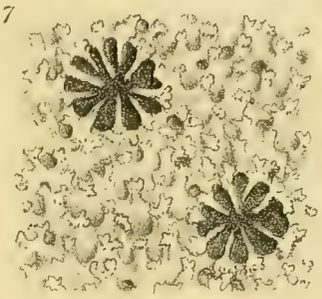
M. stratiformis X 40.

5 

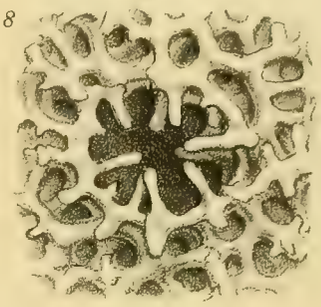
M. explanata X 24.

6 

M. tenuissima X 24.

7 

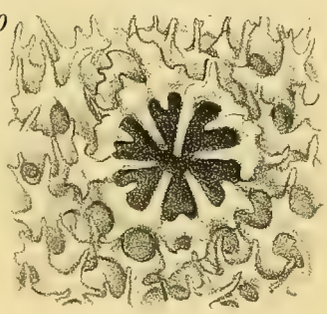
M. porosa X 40.

8 

M. reticulata X 35.

9

M. crassi-reticulata X 30.

10 

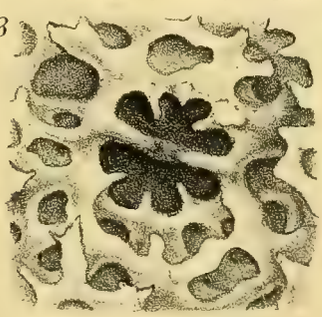
M. pallida X 30.

11

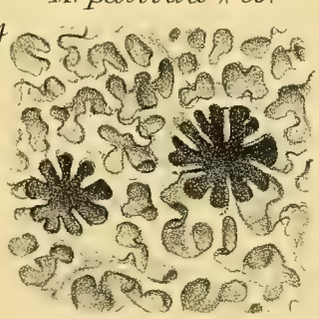
M. punctata X 25.

12

M. auricularis X 20.

13 

M. exserta X 24.

14 

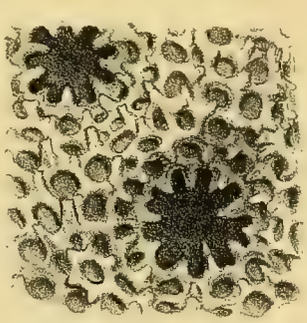
M. obtusata X 24.

15

M. bolsii X 24.

16

M. spongodes X 24.

17 

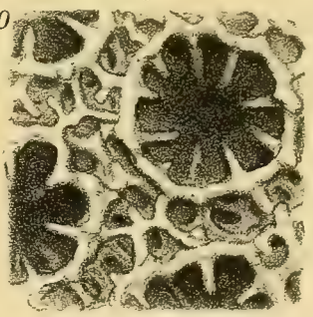
M. divaricata X 15.

18

M. mollis X 15 .

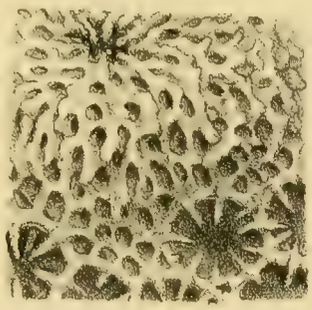
19

M. levis X 35 .

20 

M. compressa X 25.

1

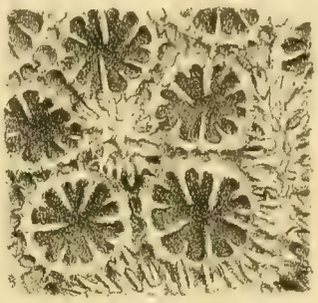


M. lobulata. × 16.

2

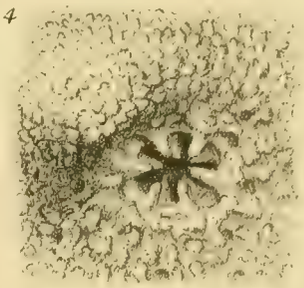
M. acanthella × 25.

3



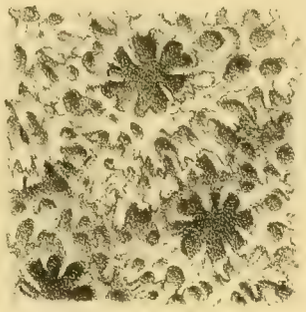
M. fungiformis × 12.

4



M. bilaminata × 20.

5



M. guppyi × 10.

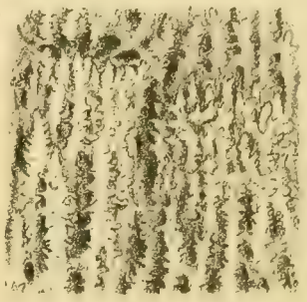
6

M. tubifera × 20.

7

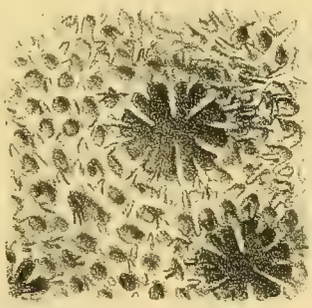
M. pulcherrima × 24.

8



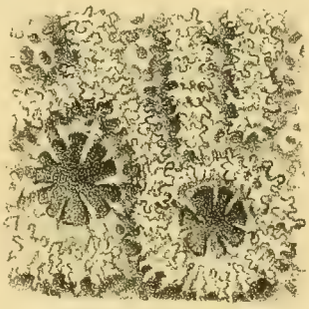
M. australiensis × 15.

9



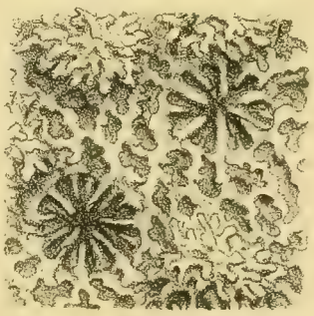
M. undata × 16.

10



M. viridis × 16.

11

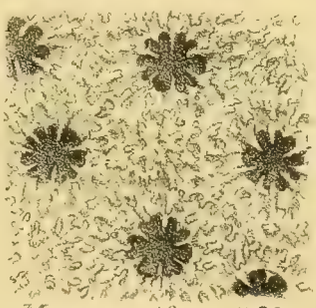


M. sinensis × 16.

12

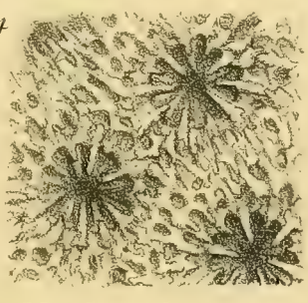
M. ambigua × 20.

13



M. mammifera × 30.

14



M. edwardsi × 20.

15

M. annularis × 20.

16

M. cactus × 16.

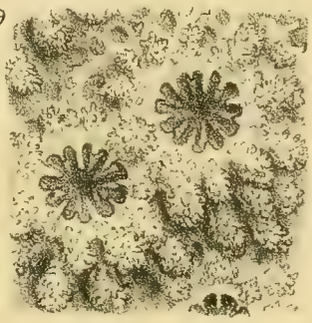
17

M. challengeri × 20.

18

M. listeri × 24.

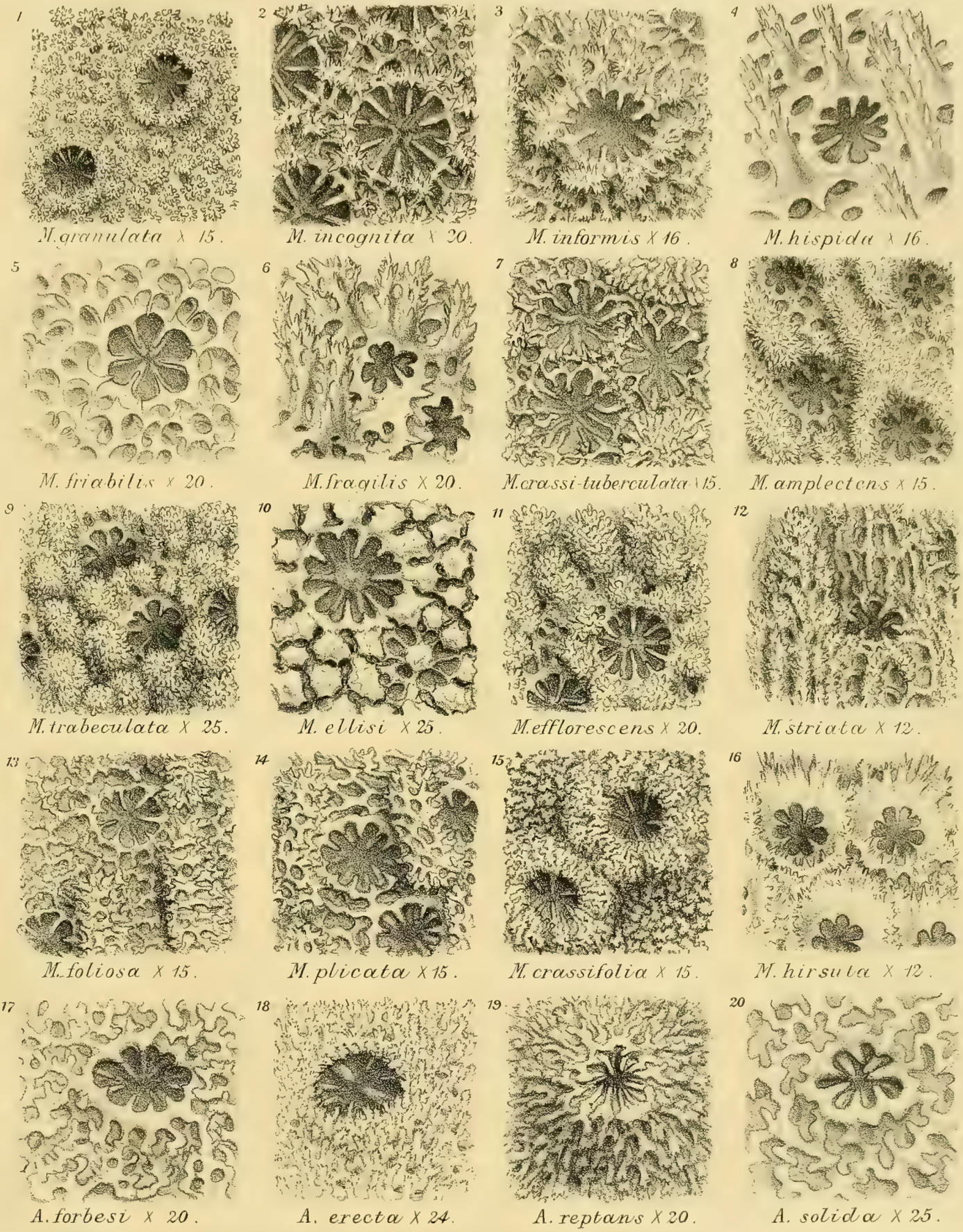
19



M. minuta × 30.

20

M. scutata × 12.



Berjeau & Highley del. et lith

Hanhart imp.

MONTIPORA AND ANACROPORA.

3 2044 072 201 882

Date Due

AUG 15 1968